Differentiating CREF Performance

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Abstract

We examine factors underlying differences in CREF performance using a sample of 65 CREFs during 1985-2002. More than half of the individual CREFs underperformed the employed benchmark. However, portfolios of CREFs performed well in both up and down markets, smaller CREFs outperformed larger CREFs, and top performing CREFs continued to outperform. Differential CREF performance appears to be attributable to property selection, rather than allocation across real estate sectors. Liquidity-constrained CREFs exhibited lower risk. CREFs with large benchmark tracking error experienced inferior performance. These findings indicate important cross-sectional differences among CREFs and diversification opportunities for pensions employing multiple CREF investment strategies.

Differentiating CREF Performance

Introduction

Real estate represents an important component of pension fund assets.[1] A substantial amount of institutionally managed pension real estate assets are invested via commingled real estate funds (CREFs). However, surprisingly little is known about the factors underlying differences in CREF performance. Early research focuses on CREF diversification potential and performance.[2] For example, Brueggeman, Chen, and Thibodeau (1984) examine the diversification benefits from adding two CREFs to a portfolio of stocks and bonds. Hartzell, Hekman, and Miles (1986) use data for a single institutionally managed real estate fund to examine diversification within the real estate sector. Myer and Webb (1993) and Myer, Webb and He (1997) examine risk-adjusted CREF performance.[3]

We extend prior literature by examining factors underlying differences in CREF performance using a sample of 65 CREFs during 1985-2002.[4] Initial results for individual CFEFs show most of the funds underperformed the *National Council of Real Estate Investment Fiduciaries National Property Index* (NPI) during 1985-2002, after adjusting for risk measured by standard deviation. Reported performance improves when using returns below the mean, or downside risk, rather than total risk. Further, we find that most of the CREFs outperformed the NPI when computing Jensen alphas that adjust for the CREF's risk relative to the NPI.

We group CREFs into portfolios and analyze risk-adjusted performance differences based on asset size, varying market condition, prior year performance, liquidity constraints, sector allocation, property selection, and benchmark tracking error. We find that the portfolios performed well against the NPI. CREF portfolios performed well in both up and down markets, smaller CREFs outperform larger CREFs, and top performing CREFs continue to outperform.

Using Sharpe's (1992) effective mix methodology, we find that sector allocation explains only a small part of the higher return of the CREFs relative to the NPI. Instead, the return differential appears to be attributable to astute individual property selection.

Supporting a liquidity proposition, we find open-end funds experienced lower standard deviations and lower betas than closed end funds. Also in support of a liquidity proposition, our sector allocation tests suggest that closed-end funds were fully invested in NPI real estate properties while open-end funds included investments in more liquid publicly traded real estate securities and cash.

We find that CREFs with high tracking errors relative to the NPI significantly underperformed. The idea that high tracking error is associated with poor performance has far reaching implications for active portfolio management. High tracking error and poor performance are attributable to a combination of overallocation to underperforming sectors and to the selection of underperforming individual properties.

Data

We examine quarterly returns for 65 pension CREFs during the 18 year period January 1985-December 2002, which is significantly longer and more current than prior CREF related studies.[5] All rates of return include both capital appreciation and income, and are calculated on a time-weighted, asset-weighted basis, gross of investment fund management fees. To be eligible for sample inclusion, a CREF had to have a performance track record of at least 15 quarters. The return series for the sample CREFs range from a minimum of 15 quarters to a maximum of 72 quarters (18 years x 4 quarters). The mean number of quarters is 49. The sample of CREFs is further divided into closed-end (n=42) and open-end (n=23) categories.

CREF returns are provided by *PIPER Money Managers*. The database contains most of the largest equity real estate funds (at least $10 million in assets) managed specifically for tax-exempt pension funds. The *PIPER* database was originally maintained by *Pensions and Investments*, a leading pension trade publication, and now is owned by *Morningstar*. The database is a primary source by which institutional

investors and consultants conduct manager searches and verify the performance of their current managers. In an attempt to obtain a relative measure of the CREF market coverage, we obtained data from *Mobius*, a competitor of *PIPER*. Mobius had 67 funds listed over the 1985-2004 sample period, which closely resemble the 65 funds found in our *PIPER* sample. We found a very high degree of overlap between the CREFs in the two databases and no differences in the reported returns for overlapping funds. Although not required, most managers submitting data to *PIPER* claim their returns are compliant with the Global Investment Performance Standards (GIPS) of the CFA® Institute. Although CREF managers face no reporting mandate (similar to hedge funds), the *PIPER* database appears to be among the most reliable available.

In addition, we employ the value-weighted property returns obtained from the NPI as the private real estate market benchmark. The properties in the NPI account for 25% of all investment grade real estate owned by pension funds (Maxwell and Saint-Pierre, 1998). According to *PIPER* representatives, nearly all of the funds in their database report to NCREIF. Therefore, the NPI likely includes most of the assets held by our sampled funds. The NPI is an index measuring the performance of properties held in CREFs and separate accounts and is calculated on an unleveraged basis, even for leveraged properties.[6] Also, as we show later, open-end CREFs may invest in more liquid real estate holdings, which would differentiate their risk even further from the NPI. We also employ returns for the Wilshire Real Estate Securities Index provided by *Wilshire Associates* as a proxy for the public real estate market in sector allocation tests. The 90-day Treasury bill returns are used with permission, from Professor Kenneth French's website.

Potential performance bias

In contrast to mutual funds, CREFs are under no legal reporting mandate. Bias is also possible since reporting funds with deteriorating performance may opt to quit submitting data. Importantly, however, *PIPER* retains data for managers who cease voluntary submissions, reducing the degree of this form of survivorship bias. We obtained *PIPER* survey data on two occasions (March 1999 and March 2003), permitting a comparison of the data provided in the two survey periods. The comparison of the surveys

affords an examination of the CREF attrition rate, the extent of any potential return revision between surveys, and an estimate of survivorship bias.[7]

To assess the attrition rate in our sample, we compare the constituents of the 1999 and 2003 surveys. In the 1999 survey, there were 63 CREFs (25 open-end and 38 closed-end). In contrast, the 2003 survey included 65 CREFs, 54 of which were common to both surveys (22 open-end and 32 closed-end funds). Thus, the CREF attrition rate between the surveys equals 14.3%, which is nearly identical to that documented by Brown, Goetzmann, and Ibbotson (1999) for offshore hedge funds (which also report performance voluntarily).[8]

We check for revisions of returns by comparing the return series of the common funds reported in both the 1999 and 2003 surveys for the time period covered by the 1999 survey. We find no revision of returns for the 22 common open-end funds. There is evidence, however, of positive revisions within the closed-end sample. For the 32 common closed-end funds, the mean quarterly return from the 1999 survey was 1.976% and from the 2003 survey was 2.029%, for a difference of 0.054%.

Survivorship bias is calculated as the performance difference between the surviving funds and the sample of all funds [also see Malkiel (1995), Brown, Goetzmann, and Ibbotson (1999), Fung and Hsieh (2000), and Liang (2000)]. We define surviving funds as those in existence throughout the entire sample period, which limits our analysis to the open-end sample due to the small number of closed-end funds in existence at the onset of the sample period. As expected, the mean quarterly performance of the open-end surviving funds (1.991%) exceeded that of the open-end portfolio (1.853%). Annually, the performance differential indicates survivorship bias of 0.55%, which is within the 0.16% – 3% range estimated for hedge funds [Brown, Goetzmann, and Ibbotson (1999), Ackerman, McEnally, and Ravenscraft (1999), Fung and Hsieh (2000) and Liang (2000)].

Methodology and results

Descriptive statistics for individual CREFs

Figure 1 provides a time-series of the cumulative value of a one-time $1 investment in the CREF sample and in the NPI starting in 1985. The Figure demonstrates that our sample period includes a representative mixture of increasing and decreasing market periods. The Figure shows a $1 investment grew to $4.15 for the CREF sample versus $3.45 for the NPI. Of the CREF sample, the closed-end CREF investment grew to $4.55 and the open-end CREF investment grew to $3.45.

Descriptive data over 1985-2002 for the CREF sample are provided in Table 1. The dates and number of quarterly observations are reported in columns 2 and 3. Means, standard deviations, and Sharpe ratios are reported in columns 4, 5, and 6. The Sharpe ratio for the NPI is reported in column 7. We calculate the NPI Sharpe ratio over the time period that coincides with the reporting period for each CREF to ensure that we use identical comparison periods. Similarly, column 8 reports the Sharpe ratio for the equally-weighted portfolio of all sampled CREFs, calculated over the period that coincides with the reporting period of the CREF. The last column presents the tracking error for each CREF relative to the NPI, defined as the square root of the sum of squared differences between the CREF return and the NPI return divided by the number of observations less one. Panel A presents the results for the 42 closed-end CREFs and Panel B presents the results for the 23 open-end CREFs. Returns are presented in percent per calendar quarter.

Table 1 shows wide variability in both returns and standard deviations across the funds over the sample period. Mean quarterly returns ranged from a low of –0.20% (AEW Capital Management LP Developmental) to a high of 8.88% (Hearthstone Advisors).[9] Our initial tests of performance rely on the Sharpe ratio (Sharpe, 1966), estimated as

$$SHP_i = (\overline{R}_i - \overline{R}_f)/s_i, \quad (1)$$

where $\overline{R}_i$ is the mean quarterly return for CREF *i* and $\overline{R}_f$ is the mean quarterly return on the 90-day Treasury bill, and s_i is the standard deviation of the quarterly returns for CREF *i*. The Sharpe ratio employs the standard deviation as the risk measure, so SHP computes the mean quarterly excess return per unit of total risk.

The Sharpe ratios presented in Panels A and B of Table 1 indicate 24 CREFs (37%) outperformed the NPI. The superior performers include 14 closed-end CREFs (33% of the closed-end sample) and 10 open-end CREFs (43% of the open-end sample). The Sharpe ratio tests suggest that most of the sampled CREFs underperformed the NPI, after adjusting for total risk.

We find, however, that the distribution of quarterly returns is skewed for most funds. For instance, 58% of the closed-end funds exhibited positive skewness, while 67% of the open-end funds exhibited negative skewness.[10] Some of the skewness coefficients were large; 76% (79%) of the closed-end (open-end) CREFs exhibited skewness greater than 0.5 in absolute value.[11] The skewed return distribution casts doubt on the validity of standard deviation as a measure of risk, suggesting the traditional Sharpe ratio may be inappropriate for CREF data. Consequently, we modify the risk measure in the denominator of the Sharpe ratio by replacing the standard deviation with the semi-standard deviation (which uses only the squared deviations of the CREF returns below the mean return in the numerator). The modified ratio is often referred to as the Sortino ratio (Sortino and Price, 1994). We note that most institutional performance software, such as that employed by Zephyr Associates and Morningstar, now routinely report results based on downside risk. We contend that the Sharpe ratio is a misleading tool for ranking CREFs if skewness exists and is not identical across funds and indices. The modified results will provide a better indication of reward per unit of risk, using a measure of risk that institutional investors widely recognize and employ in practice (Peskin, 1997). It should be noted that the main property of the Sortino ratio is its ability to capture the asymmetric behavior of returns, which implicitly incorporates higher

moments. Bacmann and Scholz (2003) discuss the properties of the Sortino ratio relative to higher moment statistics.

Table 2 provides the downside risk and Sortino ratio results. Downside risk, as defined by the semi-standard deviation, is reported in column 2. The Sortino ratio is reported in column 3 for the CREFs and in column 4 for the NPI. Downside tracking error, reported in column 5, is defined as the square root of the sum of squared differences between the CREF and NPI returns divided by the number of observations less one, using only those returns for the CREF falling below the NPI return.

Based on the Sortino ratio, the number of funds outperforming the NPI rises from 24 (37% in Table 1) to 32 (or 49% in Table 2) after adjusting for downside risk. The percentages of outperforming closed-end and open-end funds are similar to each other. We still find that less than half (49%) of the funds outperformed the overall NPI based on the Sortino ratios.[12]

The final column in Table 2 presents the percentage of quarters in which the CREF outperformed the NPI. Tests of significance between the observed percentage and 50% are performed using the nonparametric sign test for the hypothesis that the proportion (p) of successes equals 50%: H_o: p = 0.50 versus H_a: p ≠ 0.50. The test statistic for the Sign Test is:

$$\frac{\hat{p} - 0.50}{\sqrt{0.25/N}}, \tag{2}$$

where N is the number of quarters for the CREF. The test statistic approximately follows a normal distribution. The sign test provides a non-parametric test of performance. We find that the test statistic is positive for 36 CREFs (55% of the sample). Using a 0.05 level of significance, 13 CREFs (20% of the sample) beat the NPI significantly more often than half of the time and 8 (12.3% of the sample) were beaten by the NPI significantly more often than half of the time. The results of the non-parametric tests are more encouraging, but certainly do not provide overwhelming support for the use of individual CREFs. Next, we turn our attention to the performance of portfolios of CREFs.

Descriptive statistics for portfolios of CREFs

Although diversification is a stated advantage of CREFs, a performance comparison of individual CREFs versus the broad-based NPI may be unfair. An individual CREF may have a stated property-type or regional specialization, which would cause its diversifiable risk to remain high relative to the NPI. But some institutions, seeking broader diversification within the real estate class, may pursue purchasing shares of multiple CREFs. To evaluate a multiple CREF strategy, we combine the CREFs into equally-weighted portfolios. Table 3 provides descriptive statistics for the CREF portfolios and the NPI indices. The CREF portfolios provide important tests that not only summarize the results of well-diversified CREF groups but also account for cross-correlation and heteroskedasticity in the CREF returns. Portfolio test results should be statistically more powerful than tests performed on each CREF separately (Brown and Warner, 1985). Table 3 also reports the results of Jobson and Korkie (1981) tests of significance for differences in Sharpe ratios between each portfolio or index versus the NPI (see the Appendix for details of the test).

The data in Table 3 indicate that the mean quarterly return for the portfolio of all sampled CREFs (All CREFs) equaled 2.01% versus the NPI return of 1.75%. The East (South) region ranked at the top (bottom) of the regional comparisons and Apartments (Offices) ranked at the top (bottom) among the property comparisons. The Sharpe ratio for the entire CREF portfolio (All CREFs) equaled 0.44 versus 0.29 for the NPI. Although the open-end CREF portfolio recorded a lower return (1.85%) than the closed-end CREF portfolios (2.14%), the Sharpe ratios between the open-end and closed-end portfolios were nearly identical (0.41 versus 0.42, respectively), attributable to the lower standard deviation for the open-end CREF portfolio (which we discuss in greater detail later). The Jobson-Korkie tests indicate that the Sharpe ratios for the All CREF and the Open-end CREF portfolios were significantly above the Sharpe ratio for the NPI. The Sortino ratios for all the CREF portfolios (all, open and closed) exceed the NPI by a wide margin.

Collectively, the results of Tables 1-3 indicate that individual CREFs retained considerable diversifiable risk relative to the NPI. This additional risk lowered the individual CREF Sharpe ratios and led to the conclusion that many of the sampled CREFs underperformed the NPI (when measured by either total risk or downside risk, Tables 1 and 2). Creating CREF portfolios that eliminate much of the diversifiable real estate risk, however, reveals that CREF portfolios outperformed the NPI after adjusting for total or downside risk (Table 3). The quarterly return on the All CREF and the Closed-end portfolios exceeded that of the NPI significantly more often (71% and 67% of the time, respectively) than would be expected to occur by chance alone (50%).[13]

Single-index NPI performance measure for individual CREFs and CREF portfolios

We further evaluate CREFs using the single-index Jensen (1968) performance model:

$$R_{it} - R_{ft} = \alpha_i + \beta_i(R_{NPI,t} - R_{ft}) + \varepsilon_{it}, \quad (3)$$

where, the slope parameter, β_i, measures the risk for individual CREF or CREF portfolio i and ε_{it} is the random error in their regression. The intercept, α_i, measures the incremental performance after adjusting for risk relative to the NPI benchmark.[14] Equation *(3)* examines performance with the hypothesis H_o: $\alpha_i = 0$ versus H_o: $\alpha_i \neq 0$. This hypothesis is examined by the *t*-statistic on the intercept.[15] A significant positive (negative) *t*-statistic indicates superior (inferior) performance, both of which reject the null performance hypothesis.

The results of the single-index Jensen performance tests are summarized in columns 2-4 of Table 4. The Closed-end CREF and Open-end CREF results are reported in Panels A and B, respectively. Of the 65 CREFs, 46 (71% of the sample) produced positive alpha estimates.

CREF Portfolio and NPI Index results are presented in Panel C of Table 4. All three CREF portfolios significantly outperformed the NPI proxy during the sample period. Quarterly alphas were 0.271%, 0.350%, and 0.198% for the All CREF, Closed-end CREF, and Open-end CREF portfolios, respectively. These findings show that the portfolio of all sampled CREFs outperformed the NPI by 0.271% on a

quarterly basis (21.5% cumulative over the 72 quarter period), after adjusting for risk. Our single-index results concur with CREF performance findings of Myer and Webb (1993) and Myer, Webb, and He (1997) over earlier time periods.[16]

The Jensen tests provide additional evidence that the individual CREFs incurred substantial diversifiable risk, which deterred their return-to-total risk performance. When only non-diversifiable real estate market risk is considered in the performance evaluation, most of the CREFs either met or exceeded the NPI on a risk-adjusted basis.[17]

Performance over varying market conditions

Tests of performance of mutual funds over varying market conditions have been prominent in the literature dating to the 1960s (e.g., Treynor and Mazuy (1966), Fabozzi and Francis (1977, 1979), Alexander and Stover (1980), Veit and Cheney (1982), Henriksson (1984), and Chang and Lewellen (1984)). More recently, Kallberg, Liu, and Trzcinka (2000) find that most of the positive alphas for real estate mutual funds occur during down real estate periods.

We examine the performance of CREFs after identifying up and down periods using 3 different classifications: (1) up markets defined as quarters when the NPI return is positive, and down markets when the NPI return is non-positive; (2) up markets defined as quarters when the NPI return less the 90-day treasury bill return is positive, and down markets when the NPI return less the 90-day treasury bill return is non-positive; and (3) substantially up markets defined as quarters when the NPI return exceeds its mean plus one standard deviation, and substantially down markets defined as quarters when the NPI return is less than its mean minus one standard deviation.

To perform the first two tests, we run the following regression:

$$R_{pt} - R_{ft} = \alpha_{po} + \alpha_{p1} D_t + \beta_{po}(R_{NPI,t} - R_{ft}) + \beta_{p1}(R_{NPI,t} - R_{ft}) D_t + \varepsilon_{it}, \quad (4)$$

where R_{pt} is the return in quarter t for the equally-weighted portfolio of all sampled CREFs. In the first test, $D_t = 1$ for all quarters in which the NPI return exceeds zero; otherwise $D_t = 0$. In the second test, $D_t =$

1 for all quarters in which the NPI excess return exceeds zero; otherwise $D_t = 0$. The α_{po} parameter measures the down market alpha for the CREF portfolio and α_{p1} measures the change in the alpha during up market quarters. Note that we control for changes in beta also during up market quarters. In the third test, we make the following modification:

$$R_{pt} - R_{ft} = \alpha_{po} + \alpha_{p1} D_{1t} + \alpha_{p2} D_{2t} + \beta_{po}(R_{NPI,t} - R_{ft}) + \beta_{p1}(R_{NPI,t} - R_{ft})D_{1t} + \beta_{p2}(R_{NPI,t} - R_{ft})D_{2t} + \varepsilon_{pt}, \quad (5)$$

where D_{1t} equals 1 for all substantially up market quarters in which the NPI return exceeds its mean plus one standard deviation; otherwise D_{1t} equals zero. $D_{2t} = 0$ for all substantially down market quarters in which the NPI return falls below its mean minus one standard deviation; otherwise D_{2t} equals zero. Therefore, both D_{1t} and D_{2t} equal zero when the NPI return lies within its mean plus and minus one standard deviation. These quarters are considered more moderate or "directionless" in the third test. This last test will show how well the CREFs perform during more extreme up and down real estate market periods.

Results of tests over varying market conditions are reported for the portfolio of all sampled CREFs in Table 5.[18] During the 1985-2002 period, there were 63 (9) quarters in which the NPI return was positive (non-positive), 53 (19) quarters when the NPI excess return was positive (non-positive), and 8 (9) quarters in which the NPI return fell above (below) its mean plus (minus) one standard deviation. Panel A of Table 5 presents the results of the first test. Consistent with Kallberg, Liu, and Trzcinka (2000), the down period alpha is positive (0.76%) and statistically significant at the 0.10 level (t-statistic = 1.89). However, the quarterly alpha more than doubles from 0.76% during down markets to 1.68% during up markets (i.e., the estimated change in alpha or $\hat{\alpha}_{p1}$ equals 0.92%, which is also significant, t-statistic = 2.21). Results presented in Panel B for the second test show that the quarterly alpha is positive (1.67%) and significant (t-statistic = 7.21) during down markets and drops slightly to 1.52% during up markets (i.e., the estimated change in alpha or $\hat{\alpha}_{p1}$ = -0.15%, is not significant, t-statistic = -0.49).

Panel C presents results from the third test of substantially up/down test. These latter results show that the quarterly alpha is 1.75% during "directionless" periods (t-statistic equals 13.95). The alpha drops to 1.12% (i.e., $\hat{\alpha}_{p1}$ = -0.63%) during substantially up market periods and drops to 0.76% ($\hat{\alpha}_{p2}$ = -0.99) during substantially down market periods. It is important to note that although both drops in alpha are significant (t-statistics = -2.90 and -1.82, respectively), both substantially up market and substantially down market alphas (1.12% and 0.76%) remain positive. Therefore, our tests show that risk-adjusted performance for the portfolio of CREFs remains positive during down periods defined as quarters in which the raw or excess NPI return was non-positive or as quarters in which the NPI return was substantially below its mean. These findings provide additional evidence that the sampled CREF managers added value even when returns to the real estate market were poor.

We also perform the Treynor-Mazuy (1966) test of market timing:

$$R_{it} - R_{ft} = \alpha_i + \beta_{it}(R_{NPI,t} - R_{ft}) + \varepsilon_{it}, \quad (6)$$

$$\beta_{it} = b_{i0} + b_{i1}(R_{NPI,t} - R_{ft}), \quad (7)$$

such that

$$R_{it} - R_{ft} = \alpha_i + b_{i0}(R_{NPI,t} - R_{ft}) + + b_{i1}(R_{NPI,t} - R_{ft})^2 + \varepsilon_{it}. \quad (8)$$

The market-timing ability of the funds is evaluated by the t-statistic on the b_1 estimate in Equation *(8)*, where a positive (negative) t-statistic indicates superior (inferior) timing ability. The intercept in Equation *(8)* now measures the performance of the funds after controlling for a time-varying beta.[19] In this context, the alpha measures the *selectivity* ability of the fund managers.

We find that the b_1 estimate is not significant for either the portfolio of all CREFs ($\hat{b}_1$ = 0.021, *t-statistic* = 1.39) or the portfolio of closed-end CREFs ($\hat{b}_1$ = 0.013, *t-statistic* = 0.47), but is significant at the 0.10 level for the portfolio of open-end CREFs ($\hat{b}_1$ = 0.025, *t-statistic* = 1.87). Comparing results derived from Equation *(3)*, alphas drop from 0.271 to 0.204 for the portfolio of all CREFs, from 0.350 to 0.307 for the

portfolio of closed-end CREFs, and from 0.198 to 0.116 for the portfolio of open-end CREFs. Alphas should be expected to fall because the revised test measures performance after removing positive market-timing effects from the alpha. Alphas remain statistically significant for both the portfolio of all CREFs and the portfolio of closed-end CREFs, but is not significant for the portfolio of open-end CREFs (t-statistic = 1.42). We repeated the tests modeling beta as a function of the lagged excess NPI return. There are no notable changes in the results relative to those discussed for Equation *(8)*.

Size effects for portfolios

We examine the performance of CREFs based on the dollar value of assets under management.[20] Most of the closed-end CREFs are much smaller than the open-end CREFs. For instance, the mean closed-end CREF size is $134 million, ranging from $12 million to $478 million. The mean open-end CREF size is $1.34 billion, ranging from $231 million to $3.2 billion. To avoid confounding the size tests with open and closed fund effects (which we examine later), we perform our size effect tests for open end funds only, in which there is much wider spread in fund size. We classify funds according to whether they fall above or below the mean fund size. Equally-weighted portfolios are created for the small and large size groups. Then, the following regression is run:

$$R_{St} - R_{Lt} = \alpha_i + \beta_i(R_{NPI,t} - R_{ft}) + \varepsilon_{it}, \quad (9)$$

where R_{St} is the return for the small fund portfolio in quarter t and R_{Lt} is the return for the large fund portfolio in quarter t. The intercept of Equation *(9)* measures the difference in risk-adjusted performance between the small and large open-end funds. The slope of Equation *(9)* measures the difference in betas between small and large open-end funds. Our regression on Equation *(9)* for the open-end funds produces an intercept estimate of 0.30% (t-statistic = 1.65) and a slope estimate of -0.39 (t-statistic = -3.64). Therefore, our tests indicate that small funds outperformed large funds by 0.30% per quarter after adjusting for risk differences between small and large funds. The results might not be surprising considering that the NPI is an index comprising holdings of the funds. Thus, it may be difficult for large funds to beat an index in which they heavily influence.[21]

Persistence tests

Tests of persistence or "hot hands" effects for mutual funds have appeared prominently in the literature; most notably by Hendricks, and Patel, and Zeckhauser (1993), Grinblatt, Titman and Wermers (1995), and Wermers (1996). More recently, Carhart (1997) ranks equity mutual funds and finds that the best performing equity mutual funds continue to outperform the worst performing funds by 0.67% per month in the year after the funds are ranked. We perform a similar test for CREFs by sorting and classifying CREFs into quintiles based on compound quarterly return in year *t-1*. We then compute the equal-weighted average quarterly returns for each quintile for the 4 quarters of year *t*. The CREFs are reclassified each year. Quintile 1 contains the funds that performed the worst in year *t-1*. Quintile 5 contains the funds that performed the best in year *t-1*. If persistence exists among the sampled funds, then the Quintile 5 return in year t will exceed the Quintile 1 return. We compare rates of return and alphas across the Quintiles.

Results of the persistence tests are reported in Table 6. Mean quarterly excess returns rise steadily from -0.25% for Quintile 1 to 1.67% for Quintile 5, respectively. The mean quarterly difference between the returns for Quintile 5 and Quintile 1 is 1.92%. Interestingly, the annualized difference (7.9%) is very close to that found by Carhart for equity mutual funds deciles 1 and 10 (8.3%). Quarterly alphas also rise steadily from -0.86% for Quintile 1 to 1.34% for Quintile 5. The difference in alphas between Quintile 5 less Quintile 1 equals 2.19% and is statistically significant (t-statistic = 5.6). The Quintile 5 return in year t exceeds the Quintile 1 return 81% of the time. Our findings indicate that, similar to equity mutual funds, CREFs exhibit persistence in performance both on an excess return and risk-adjusted return basis.

Performance attribution analysis

Single-index alphas provide an evaluation of the overall risk-adjusted performance of funds, but do not distinguish between the contributions of the two major steps in fund management: sector allocation and individual property selection. Sector allocation refers to the manager's decision to consciously overweight or underweight a real estate sector relative to the benchmark. Individual property selection refers to the

ability of managers to select individually outperforming properties. Significant performance may result from just one or the joint impact of both major decisions. To date, no other study has performed an attribution analysis to estimate the effects of sector allocation and property type selection on CREF performance.

According to traditional performance attribution analysis, the contribution of sector allocation is computed as the product of the fund's differential exposure to each sector times the differential performance of each sector that comprises the overall benchmark. A fund manager exhibits superior sector allocation by overweighting the outperforming sector or underweighting the underperforming sector. In either case, the product of differential weight and differential performance will be positive. A CREF's differential weight is measured as the difference between the CREF's weight to the sector and the NPI weight to the same sector. The differential performance of the sector is measured as the difference in returns between the sector and the NPI.

To estimate CREF allocations, we employ the returns-based allocation analysis introduced by Sharpe (1992), who shows that the technique works very well when applied to mutual funds.[22] The technique is also used routinely by professional fund advisory services (e.g., Zephyr Associates, Ibbotson Associates, Morningstar, etc.) to infer the weights and resulting investment style of investment funds.

In our performance attribution analysis, we employ two multi-index regression models. First, we construct a geographic region regression model in which quarterly returns for four mutually exclusive NPI regional indices are used (East, South, Midwest, and West) to estimate the allocation of the funds across the different geographic regions.[23] Next, we construct a property type regression model, using the quarterly returns of four property indices comprising the NPI (Office, Apartments, Retail, and Industrial).[24]

The two regression equations are:

$$R_{it} = b_{iE}R_{EAST,t} + b_{iS}R_{SOUTH,t} + b_{iMW}R_{MIDWEST,t} + b_{iW}R_{WEST,t} + \varepsilon_{it}, \quad (10)$$

$$R_{it} = b_{iO}R_{OFFICE,t} + b_{iA}R_{APT,t} + b_{iR}R_{RETAIL,t} + b_{iI}R_{IND,t} + u_{it}, \quad (11)$$

where, for quarter t, each R_t is the return on the CREF portfolio, regional index, or property index. The slope estimates from Equations *(10)* and *(11)* provide the effective mix by either the geographic mix ($b_{iE,}$ b_{iS}, b_{iMW}, and b_{iW}) or the property type mix ($b_{iO,}$ b_{iA}, b_{iR}, and b_{iI}) of portfolio *i*. The regression is constrained such that the slopes must sum to one and be nonnegative.

Total return differential is defined simply as the difference between the CFEF return and the NPI return. The contribution of sector allocation to the total return differential is estimated as follows:

$$\sum_{j=1}^{4} \hat{b}_{ij} \overline{R}_{INDEX,j} - \sum_{j=1}^{4} \hat{b}_{NPI,j} \overline{R}_{INDEX,j} \ , \quad (12)$$

where the first sum is the estimated naïve return for CREF *i* that allocated the b_{ij} weights to the sector indices returns ($\overline{R}_{INDEX,j}$ are the mean returns for the four real estate indices employed, either regional or property indices). In other words, the first sum is the return for a CREF that actively pursues sector allocation decisions, but passively pursues property selection. The second sum equals the benchmark return using the effective weights derived for the NPI.

The contributions of individual property selection to the overall relative performance of the CREF are estimated as:

$$\overline{R}_i - \sum_{j=1}^{4} \hat{b}_{ij} \overline{R}_{INDEX,j} \ . \quad (13)$$

Results of the constrained regressions are provided in Table 7. The effective mix for the NPI is reported in the first row of each Panel of Table 7. The following rows report the respective effective mixes for the All CREF, Closed-end CREF, and the Open-end CREF portfolios.

Panel A of Table 7 reports the effective mix regional allocations. The regional allocations show that the All CREF portfolios outperformed the NPI by 26 basis points (mean All CREF return minus the NPI = 2.01% minus 1.75%), on average, per quarter.[25] Of these 26 bps, 5.3 bps (20.4%) were attributable to the

CREF portfolio geographic sector allocation and 20.2 bps (77.7%) were attributable to individual property selection. The CREF portfolio effective weight is largest for the best performing East region, the main performance enhancer to its positive geographic sector allocation attribution.

Panel B of Table 7 reports the effective mix property-type allocations. Findings indicate that 8.5 bps (32.7%) of the 26 basis point quarterly differential performance relative to the NPI were attributable to the CREF property-type sector allocation; 15.9 bps (61.2%) of the performance differential were attributable to the CREF portfolio individual property selection.

The results presented in Table 7 indicate that, on average, the superior performance of the portfolios of CREFs reported earlier (see Table 3) was attributable mainly to individual property selection rather than to either geographic or property sector allocation. The sole exception is found using the property-type sector model for open-end CREFs in which, after controlling for sector allocation, individual property selection actually detracted from performance. However, we caution the reader about the accuracy of the Open-end effective mix results. As we show in the next Section, liquidity constraints induced open-end CREFs to invest a material percentage in assets outside the traditional NPI sectors, which are not included in effective mix regressions above.

Liquidity constraints

In this section, we examine the effects of liquidity constraints on the performance and sector allocation of CREFs. Open-end funds must maintain liquidity to meet ongoing investor purchase/sale demands, a constraint to which the closed end funds are not subject. The CREF sample standardizes on asset class objective but differs according to liquidity constraint. Thus, the liquidity test described below provides a unique opportunity to examine differences in CREF risk across funds of similar objective but with different investment constraints.

Initially, we test the liquidity proposition by examining differences in variances between open-end and closed-end funds. Since open-end funds need to hold cash for redemptions, their return variance should be

less than the return variance for closed-end funds. We perform an F-test for the difference in variances, in which the ratio of the two variances follows an F-distribution with 71 degrees of freedom in both the numerator and denominator.[26]

The summary statistic presented back in Table 3 show the standard deviations for the portfolio of closed-end and open-end funds are 2.05% and 1.37%, respectively. The ratio of the closed-end to open-end variances equals 2.24, which is statistically significant at the 0.01 level. Therefore, we find that the variance of returns for the open-end fund sample is significantly below the variance of returns for the closed-end fund sample, which supports the liquidity proposition.[27] Consistent with this result, recall from our single-index tests on Equation *(3)* that the open-end CREF portfolio beta was significantly less than the closed-end CREF portfolio beta (0.80 versus 1.09, t-statistic for difference in betas equals -3.06).

The liquidity proposition contends that the open-end funds will allocate larger percentages to more liquid assets, such as securitized real estate and cash. We perform Sharpe's effective mix tests on the portfolios of closed-end and open-end funds to examine this possibility. In the current tests, however, we use indices that represent both illiquid and liquid assets in which open-end CREFs are likely to invest: the NPI to represent private real estate, the Wilshire Real Estate Securities Index (WRE) to proxy public real estate, and Treasury Bills to reflect liquid risk-free investments. We run a constrained regression (slopes are nonnegative and sum to one) on the following equation for the portfolios of open and closed-end funds:

$$R_{it} = b_{iNPI}R_{NPI,t} + b_{iWRE}R_{WRE,t} + b_{iTBILL}R_{TBILL,tt} + e_{it}. \quad (14)$$

Results reveal that estimates for the three slopes in Equation *(14)* for the closed-end portfolio equal 1, 0, and 0, respectively, implying that, as a group, closed-end funds invested solely in private real estate as proxied by the NPI. In contrast, the three respective slope estimates for the open-end funds equal 0.83, 0.02, and 0.15. Thus, the estimated allocation for the portfolio of open-end funds was 83% to NPI assets, 2% to WRE assets and 15% to cash. These findings support the liquidity proposition and explain why the variance of returns (and beta) for open-end funds was less than that of the closed-end funds. These results

imply closed-end CREFs should enjoy a performance advantage over open-end funds. Our performance tests support these propositions, revealing positive differences in risk-adjusted performance between the closed-end versus open-end CREFs.

NPI benchmark tracking error

Tracking error is a cost of active management and can result from CREF deviations from either the NPI weightings across major real estate sectors (i.e, sector allocation) or from the NPI weighting across individual properties (individual property selection) within each sector. The deviations can be the result of active sector allocation and/or a specialization focus of the CREF. In either case, it would be helpful to know if performance of CREFs is related to tracking error. For this purpose, we replicate the single index tests of Equation *(3)*, after creating five CREF portfolios on the basis of tracking error. We rank CREFs from low to high tracking error and classify each CREF into one of five Tracking Error portfolios (TE1 through TE5). The first quintile TE1 contains the funds with lowest tracking error and TE5 contains the funds with highest tracking error.

Tracking error for each CREF is estimated as the square root of:

$$\frac{\sum (R_{it} - R_{NPI,t})^2}{N-1} \quad . \tag{15}$$

Results for TE1 and TE5 are provided in Panel C of Table 4. Quarterly alphas equal 0.25% and -0.58% for the low tracking error (TE1) and the high tracking error (TE5) portfolios, respectively. Both alpha estimates are statistically significant at the 0.05 level. Additionally, the mean quarterly returns for TE1 and TE5 are 1.90% and 1.61%, respectively, and Sharpe ratios are 0.47 and 0.08, respectively. These results are startling. The annualized differential alpha equals 3.36% and the cumulative differential alpha over the 72 quarter sample period soars to 81%. Further research is needed in this area to identify the causes of the huge difference in risk-adjusted performance. Part of the reason may be attributable to the high beta (2.04 for TE5 versus 0.78 for TE1) of the high TE portfolio, which drives up the required

benchmark return. A high beta certainly is expected of the high tracking error CREFs, but clearly the high TE CREFs did not deliver the returns commensurate with their high volatility.

Summary and conclusions

We analyzed the performance of 65 pension commingled real estate funds (CREFs) over the 18-year period 1985 - 2002. We tested performance of the CREFs after adjusting for both total risk and for downside risk. Our tests showed that, individually, the CREFs did not outperform the NPI. Performance improved after adjusting returns for downside risk, rather than total risk. But still only about half of the CREFs outperformed the NPI.

Total risk and downside risk-adjusted performance improved markedly after combining CREFs into portfolios. Individual CREFs and CREF portfolios also performed well when evaluated after adjusting for risk relative to the NPI. This finding suggests that individual CREFs retained considerable diversifiable risk, which diminished when combined into portfolios. This result makes sense because many CREFs specialize by property type or geographic region, thereby retaining diversifiable risk.

We grouped CREFs into portfolios and analyzed risk-adjusted performance differences based on asset size, varying market condition, and prior year performance. We find that CREF portfolios performed well in both up and down markets, smaller CREFs outperform larger CREFs, and top performing CREFs continue to outperform.

We conducted a performance attribution on the CREF sample to identify the sources of differential performance relative to the NPI. We explained that differential performance may arise from the use of different weighting across the major real estate sectors (i.e., sector allocation) or from the purchase of significantly undervalued properties (i.e., individual property selection) relative to the NPI. We estimated the weightings of the CREFs across four regional NPI indices and across four property-type NPI indices. We found significant differences in weightings across the CREF portfolios, but that most of the

differential performance of the CREFs relative to the NPI was attributable to individual property selection.

We examined a liquidity proposition in which open-end CREFs hold more liquid assets and produce lower volatility estimates. Results supported the proposition. Standard deviations and betas were significantly lower for open-end CREFs than for closed-end CREFs. Moreover, effective mix tests suggested that open-end CREFs also invested in securitized public real estate and in cash in order to meet the higher liquidity constraints. These more conservative cash allocations may be the major reason why open-end CREFs underperformed closed-end CREFs during the period.

Last, we classified CREFs by tracking error relative to the NPI and found the quintile with the highest tracking error significantly underperformed on a risk-adjusted basis. Individual CREFs not only retained considerable diversifiable real estate risk but some also incurred large tracking error relative to the real estate benchmark, which may have led to significant underperformance.

Collectively, our results indicate that risk-adjusted CREF performance may vary considerably and may be affected by varying market conditions, fund size, prior performance, property selection, liquidity constraints, and tracking error. We conclude from these findings that individual CREFs are insufficient in meeting the pension real estate diversification objective. In fact, pensions may be taking unanticipated risks when hiring a single CREF to fulfill their real estate diversification mandate.

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Endnotes

[1] By 2003, real estate, mostly invested in unsecuritized, private properties, comprised 5.3% of the $3.1 trillion pension fund assets (Pension Real Estate Association, March 2004, *Plan Sponsor Research Report)*. Moreover, the real estate asset class currently produces nearly 20% of total pension income and provides cash flow that is increasingly important as pensions seek to minimize external funding requirements in an environment of deteriorating funding ratios (see, SSR Realty Advisors, 2003, *Institutional Real Estate Letter*).

[2] The diversification benefit of adding real estate to multi-asset portfolios is well documented. See Webb and Rubens (1987), Ennis and Burik (1991), Giliberto (1993), and Kallberg, Liu, and Greig (1996). CREFs also offer economies of scale that lower management costs for pension investors, and professional management specializing in real estate investment (Radcliffe, 1994, p. 52).

[3] Fletcher (1993) examines differences in returns, over 1983-1988, across 18 open-end CREFs based on beginning-of-year fund characteristics. However, he does not control for differences in risks associated with the returns he examines.

[4] The majority of private pension fund assets are managed by a highly concentrated industry of 100 institutional real estate investment managers that offer two investment structures differing only by ownership (see, Institutional Real Estate, Inc., 1998, "The Language & Culture of the Pension Real Estate Investment Market"). Also, according to the Pension Real Estate Association, March 2003, CREFs are more popular vehicles among pensions with less than $25 billion in assets. The separate account format is favored by larger pension plans. The database we employ includes separate accounts.

[5] Our sample includes both separate accounts and commingled funds. For simplicity, we refer to all sampled funds as CREFs.

[6] The NPI is not an index based on the performance of CREFs, which may have leveraged ownership of properties. Therefore, the CREF returns are leveraged, while the NPI returns are unleveraged. This difference highlights the importance of risk-adjusting in the tests of performance. We thank one of the anonymous reviewers for helping us with this distinction and explanation.

[7] More recently, Malkiel and Saha (2005) allege that hedge fund managers overstate returns by several percentage points. One of the charges includes "backfilling bias", which is the use of backtested results. PIPER does not accept backtested returns, so no backfilling bias is present in our data. Also, see Van and Song (2004) who offer evidence countering many of the claims made in the Malkiel-Saha paper (http://www.hedgefund.com/news/press/Malkiel_Paper_Flawed.pdf).

[8] We thank an anonymous referee for noting that some CREFs have finite lives. Thus, the attrition rate could include funds that simply matured between 1999 and 2003.

[9] The Hearthstone performance obviously stands out from the rest of the sample. We examined the data carefully and found quarterly returns of 103% followed by negative 42%. We also cross-checked against the CREF database maintained by Zephyr Associates. Their quarterly returns for Hearthstone were identical to the set provided by PIPER. We also contacted Hearthstone representatives directly who

confirmed the data. Hearthstone explained that their returns were volatile because it was a small fund with low market value.

[10] Young and Graff (1995) found post-1986 Russell-NCREIF property returns were negatively skewed, consistent with the results for our open-end CREF sample, but in contrast to those of the closed-end CREF sample. Liu, Hartzell, and Grissom (1992) employ an asset pricing model that incorporates a (negative) skewness premium. The authors examine CREF returns over 1979-1989 and find positive skewness, which would indicate a lower required return for CREFs in their asset pricing model relative to the single factor model.

[11] A skewness coefficient in excess of 0.5 is considered excessive for samples of size 100 or larger drawn from a normal distribution (DeFusco, McLeavey, Pinto, and Runkle, 2004, page 146).

[12] We note that decreases in measured risk and increases in reported performance are fairly uniform across CREFs. For instance, the correlation between standard deviations and semi-standard deviations is 0.81, the correlation between Sharpe ratios and Sortino ratios is 0.94, and the correlation between tracking error and downside tracking error is 0.95. Therefore, the fund rankings are unlikely to change materially.

[13] We also note that the Closed-end CREF portfolio beat the Open-end CREF portfolio 56% of the time.

[14] We do not claim that the NPI is a mean-variance efficient benchmark. We merely claim that it is a popular benchmark against which CREF managers are evaluated and that our tests measure the incremental performance of the CREFs after adjusting for risk relative to the NPI.

[15] While we perform the single-index tests for each CREF, we limit our inference conclusions to the portfolios of CREFs. The portfolios exhibit far less departure from normality than the individual CREFs. The skewness for the closed end fund portfolio is negative .59, which is slightly above the acceptable range. Moreover, the D'Agostino test for skewness indicates that the assumptions of no skewness and no kurtosis is supported for the single-index residuals for the portfolio of open-end CREFs (p-value of the D'Agostino test = 0.79 for the null hypothesis of no skewness and p-value = 0.92 for the null hypothesis of no kurtosis). Moreover, Greene (2003, pages 67-69 and 104-108) shows when the original data are non-normal, the usual t-statistic for the regression parameters follows a standard normal asymptotic distribution. He claims that the asymptotic properties hold except in the most extreme skewness cases. At the very least, the reader can interpret the t-statistics as the standardized distance from zero of each estimate (without the usual inference interpretation). Note that the intercept and slopes presented in our tables are derived using White's heteroskedasticity consistent estimator.

[16] We also ran multi-index tests in which the multiple indices were the four NPI regional indices. Alphas for the CREF portfolios remained positive and significant. Similar results were found when using the four NPI property-type indices.

[17] We replicated tests after applying data smoothing corrections recommended in Geltner (1993). We find that the rank correlation of CREFs using alpha rankings before and after smoothing corrections are applied is very high (rank correlation equal to 0.87) and the regression of unsmoothed alphas against smoothed alphas gives a slope indistinguishable from one and an intercept indistinguishable from zero, with an R^2 equal to 75%. From these results, we feel the extent of the appraisal smoothing problem is similar across CREF portfolios and CREF indices and does not have a material effect on our results. We thank David Geltner for his suggestions along these lines.

[18] Results for portfolios of open-end and closed-end funds are available from the authors upon request.

[19] Note one reason the betas might vary over time is because the funds use leverage. Fund betas are likely to rise during periods of higher leverage. Presumably, fund managers may attempt to adjust leverage to exploit favorable market conditions.

[20] McIntosh, Liang, and Tompkins (1991) found that small capitalization U.S. real estate investment trusts (REITs) produced a higher risk-adjusted return than their larger counterparts. To show that market capitalization seemed to have little impact for property indices during the sample period, we ran a regression of the value-weighted NPI against the equal-weighted NPI, resulting in an intercept and slope equal to 0.000015 and 0.98, respectively. The R^2 equaled 0.88. The *t-statistic* for the intercept equals 0.014 and the *t-statistic* for the slope (for a test of the null hypothesis that the slope equals 1) equals negative 0.44. Therefore, we cannot reject the hypotheses that the intercept equals zero or that the slope equals 1. Given the strength of these results, we make no attempt in this paper to distinguish tests based on mean property size. Instead, we examine differences based on the size of each CREF rather than on mean size of the properties held by each CREF.

[21] We thank the editor, Crocker Liu, for suggesting this test and explanation.

[22] For a comparison of holdings-based and returns-based allocation analysis, see Christopherson (1995) and Trzcinka (1995). Also, see Myer and Webb (2000) who perform property attribution tests on a sample of REITs, and Buttimer, Gallo, Lockwood, and Rutherford (1997) who perform similar tests on mortgage backed security funds.

[23] Grissom, Hartzell, and Liu (1987) were among the first to discuss the impact of geographic regions on real estate prices.

[24] Prior to performing the attribution analysis, we regressed market-adjusted CREF returns (CREF return minus NPI return) against the regional indices. Slopes from the regression measure differences in asset class exposures between the CREF portfolio and the NPI. The hypothesis that all (differential) slopes simultaneously equal zero is rejected for both regressions of the Open-end CREF portfolio against the regional indices and against the property indices. The hypothesis also is rejected for the regression of the Closed-end CREF portfolio against the property indices. These findings support the conclusion that the CREF portfolios did not weight the asset classes the same as the NPI, especially when examining the property type indices. The result provides further support for the examination of sector allocation effects.

[25] The "NPI effective benchmark return" equals the weighted average of the NPI effective mix weights times the real estate asset class returns. Note that the NPI effective benchmark return is very close (1.755%), but not exactly equal to the NPI mean return (1.75%). The fact that the difference is so slight (0.5 bps using the regional asset class model and 1.6 bps using the property-type asset class model) is very encouraging and further evidence that the effective mix provides excellent approximations. The slight difference is likely the result of using mean weights and returns in the attribution analysis, rather than using rolling weights and returns that would allow for more dynamic time-varying weights and returns.

[26] To ensure that our conclusions from the liquidity test are not driven by fund size effects, we compare the variance of returns between small and large open-end funds. We find that the variances are not significantly different (F-statistic equals 1.11). Therefore, the difference in variances that we document between open and closed-end funds are not attributable to fund size differences. We do not run the test for

equality of small and large fund variance for closed-end funds because all the closed-end funds are small and there is very little variability in closed-end fund sizes.

[27] We also note from Table 1 that the average of the 23 standard deviations derived for the 23 open-end CREFs equals 2.40% while the average of the 42 standard deviations derived for the 42 closed-end CREFs equals 3.59%, which is 50% above the open-end value. This result also supports the liquidity proposition.

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Appendix

Tests of Differences in Sharpe Ratios

To provide a formal test of significance for the Sharpe performance tests, we examine the hypothesis

$$H_o: SHP_i = SHP_{NPI} \tag{A.1}$$

for differences between the Sharpe ratios of each CREF versus the real estate benchmark (the NPI). Jobson and Korkie (1981) recommend the transformed test statistic:

$$TSHP_i = s_{NPI}\bar{r}_i - s_i\bar{r}_{NPI}, \tag{A.2}$$

where, for our purposes, $\bar{r}_i$ is the sample mean excess return for CREF i, $\bar{r}_{NPI}$ is the sample mean excess return for the NPI, s_i is the sample standard deviation of returns for CREF i, and s_{NPI} is the sample standard deviation of the NPI. Using a Taylor series expansion on Equation *(A.2)*, Jobson and Korkie show that the mean of the transformed difference in Sharpe ratios, *TSHP*, is:

$$E(s_{NPI}\bar{r}_i - s_i\bar{r}_{NPI}) = (\sigma_{NPI}\mu_i - \sigma_i\mu_{NPI})\left(1 - \frac{1}{4N} + \frac{1}{32N^2}\right). \tag{A.3}$$

Jobson and Korkie show that the asymptotic distribution of the *TSHP* statistic is normal with mean equal to $\sigma_{NPI}\mu_i - \sigma_i\mu_{NPI}$ and variance equal to:

$$\theta = \frac{\sigma_i^2\sigma_{NPI}^2}{N}\{2 - 2\rho_{i,NPI} + 0.5[(\mu_i/\sigma_i)^2 + (\mu_{NPI}/\sigma_{NPI})^2 - \frac{(\mu_i\mu_{NPI})(1+\rho_{i,NPI}^2)}{\sigma_i\sigma_{NPI}}]\}, \tag{A.4}$$

where μ_i is the mean excess return for CREF i, μ_{NPI} is the mean excess return for the NPI, σ_i is the standard deviation of returns for CREF i, σ_{NPI} is the standard deviation of returns for the NPI, and $\rho_{i,NPI}$ is the correlation of returns between CREF i and the NPI.

The Performance Hypothesis in Equation *(A.1)* is transformed and restated as:

$$H_o: \sigma_{NPI}\mu_i - \sigma_i\mu_{NPI} = 0. \tag{A.5}$$

The null hypothesis is tested with the following z-statistic:

$$z_i = TSHP_i / \sqrt{\hat{\theta}}, \tag{A.6}$$

where

$$\hat{\theta} = \frac{s_i^2 s_{NPI,i}^2}{N} \{2 - 2\hat{\rho}_{i,NPI} + 0.5[(\bar{r}_i / s_i)^2 + (\bar{r}_{NPI,i} / s_{NPI,i})^2 - \frac{(\bar{r}_i \bar{r}_{NPI,i})(1 + \hat{\rho}^2_{i,NPI})}{s_i s_{NPI,i}}]\}, \quad \text{(A.7)}$$

where $\bar{r}_{NPI,i}$ and $s_{NPI,i}$ are the mean excess return and standard deviation, respectively, for the NPI computed over all quarters spanned by CREF *i*.

Equation *(A.7)* follows an asymptotic normal distribution with mean equal to zero and standard deviation equal to one. Significant performance is found if the Sharpe ratios for CREFs are significantly different from the NPI. Because the power of the tests might be weak for small samples, we place more emphasis on the portfolio tests that span the entire 72 quarter sample period. In their simulation, Jobson and Korkie show that the mean of the variance estimate approximates the asymptotic variance when the sample size reaches 24. The authors conclude (page 900) that the z-statistic is "quite powerful although moderately large samples are required."

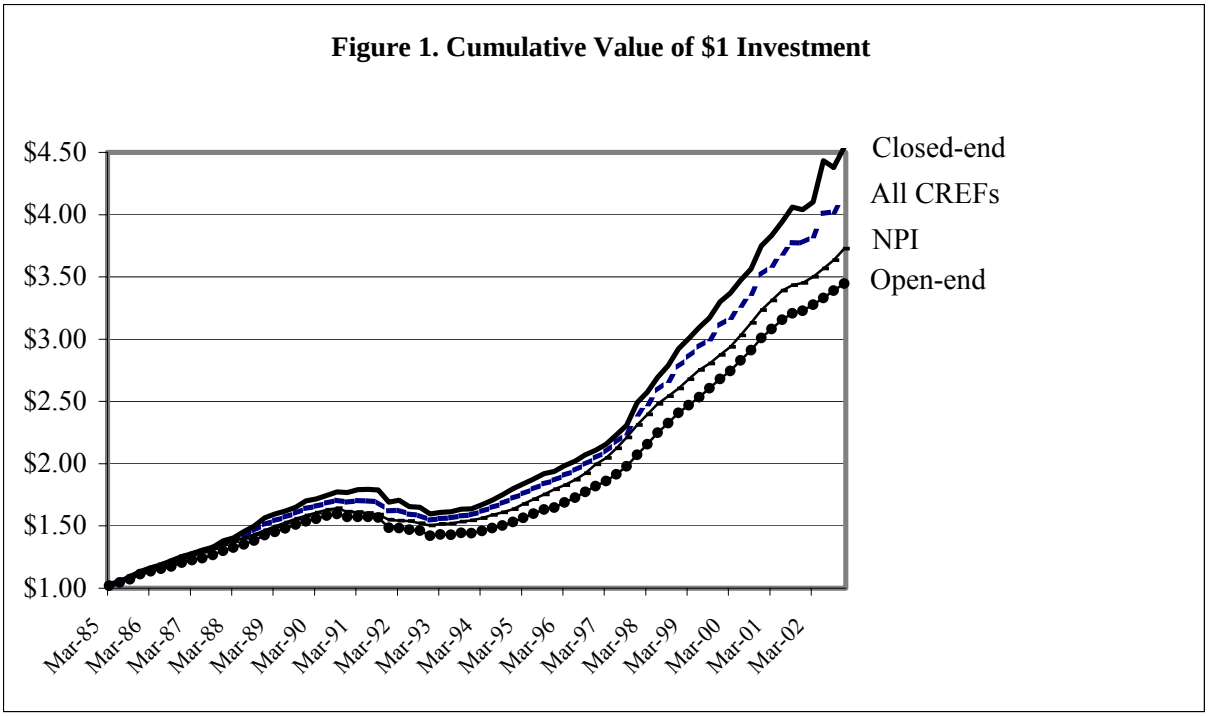

Figure 1. Cumulative Value of $1 Investment
This Figure provides the cumulative value of a one-time $1 investment in the CREF samples and in the NPI starting in 1985 and ending December 2002. Equally-weighted portfolios are created of all funds, closed-end funds, and open-end funds.

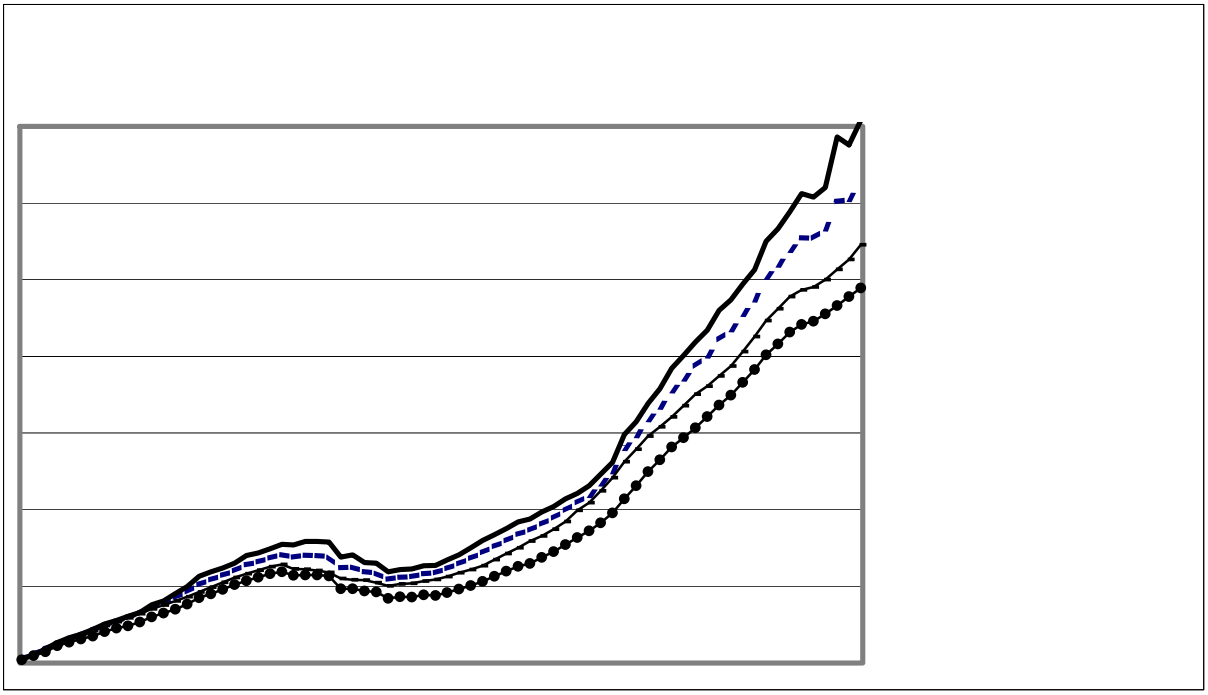

Table 1
CREF Descriptive Statistics: 1985-2002

Columns 2-6 of this table provide the dates, number of quarterly observations (N), mean quarterly returns, standard deviations, and Sharpe ratios, respectively, for each of the sampled CREFs. Column 7 presents the Sharpe ratios for the NCREIF Property Index (the NPI) computed over the period of existence for each CREF. Column 8 presents the Sharpe ratios for the equal-weighted portfolio of all sampled CREFs, computed over the period of existence for each CREF. Column 9 presents the tracking error for each CREF relative to the NPI. Returns are presented in percent per calendar quarter. The results for the closed-end CREFs (n=42) are presented in Panel A and those for the open-end CREFs (n=23) are provided in Panel B. The mean and standard deviation for the quarterly Treasury bill return was 1.29% and 0.43%, respectively, during the sample period.

1	2	3	4	5	6	7	8	9
Panel A. Closed End Funds	**Dates**	**N**	**Mean Return**	**Standard Deviation**	**CREF Sharpe Ratio**	**NPI Sharpe Ratio**	**ALL CREF Sharpe Ratio**	**CREF Tracking Error**
AEW Capital Management LPAEW Partners I	Dec. '96-Dec '02	25	3.45	4.04	0.59	1.73	1.40	14.82
AEW Capital Management LPAEW Partners L	Mar. '97-Sep. '00	15	3.48	5.41	0.41	2.76	1.94	26.32
AEW Capital Management LPCopley Fund	Mar. '87-Sep. '00	55	0.49	6.22	-0.13	0.18	0.30	29.31
AEW Capital Management LPCopley Fund I	Sep. '88-Mar. '02	55	2.15	2.36	0.37	0.21	0.31	4.28
AEW Capital Management LPCopley Investors	Mar. '85-Sep. '00	63	1.29	5.85	-0.01	0.22	0.36	22.82
Clarion Partners Direct Equity	Mar. '91-Mar. '02	45	2.62	2.81	0.53	0.29	0.38	4.97
Hearthstone Advisors Hearthstone	Mar. '93-Sep. '02	39	8.88	18.58	0.42	1.07	1.06	390.12
Heitman Capital Mgmt Endowment & Found.III	Jun. '86-Dec. '02	67	1.29	3.46	0.01	0.27	0.41	7.55
Heitman Capital Mgmt Endowmentt Found. II	Mar. '90-Sep. '00	43	1.88	2.96	0.22	0.15	0.25	7.98
Heitman Capital Mgmt Group Trust I	Mar. '85-Sep. '00	63	2.12	4.08	0.18	0.22	0.36	9.76
Heitman Capital Mgmt Group Trust IV	Jun. '86-Sep. '00	58	1.41	5.58	0.02	0.20	0.32	22.21
Heitman Capital Mgmt Group Trust V	Sep. '89-Dec. '02	54	1.90	2.78	0.26	0.24	0.35	4.99
Heitman Capital Mgmt HREF I	Mar. '85-Sep. '00	63	0.17	5.13	-0.23	0.22	0.36	21.50
Heitman Capital Mgmt HREF II	Mar. '86-Sep. '00	59	1.29	3.69	-0.01	0.20	0.33	9.41
Heitman Capital Mgmt HREF IV	Jun. '89-Dec. '02	55	1.18	2.49	-0.01	0.23	0.35	6.46
Heitman Capital Mgmt HREF V	Mar. '92-Dec. '02	44	1.90	2.18	0.39	0.61	0.67	5.66

Table 1, Continued

Panel A. Closed End Funds	Dates	N	Mean Return	Standard Deviation	CREF Sharpe Ratio	NPI Sharpe Ratio	ALL CREF Sharpe Ratio	CREF Tracking Error
Henderson Investors CASA Group	Dec. '93-Dec. '02	37	3.67	2.64	0.97	1.29	1.24	9.98
INVESCO Inc Direct Equity	Mar. '85-Dec. '01	68	2.82	2.55	0.58	0.26	0.39	9.17
L&B Realty Advisors Inc Property Fund I	Dec. '85-Sep. '00	60	1.42	3.96	0.02	0.21	0.34	9.62
L&B Realty Advisors Inc Separate Acct	Mar. '85-Mar. '02	69	2.45	3.51	0.32	0.26	0.40	9.36
L&B Realty Inv Program	Mar. '95-Jun. '01	26	2.31	3.13	0.33	2.00	1.61	10.68
L&B Realty Property Fund III	Mar. '90-Mar. '02	49	1.46	3.96	0.07	0.21	0.31	10.20
L&B Realty Property Fund IV	Mar. '90-Mar. '02	49	1.82	2.51	0.25	0.21	0.31	6.66
Lend Lease Real Estate Fund C	Jun. '96-Sep. '02	26	2.59	2.49	0.59	1.78	1.34	4.31
Lend Lease Real Estate InCore Mortgage	Mar. '95-Sep. '02	31	2.49	2.00	0.66	1.62	1.28	4.73
Lend Lease Real Estate InCore Property	Dec. '90-Sep. '00	40	1.87	3.79	0.18	0.18	0.28	12.97
Lend Lease Real Estate VEF II	Sep. '96-Sep. '02	25	2.83	3.86	0.44	1.78	1.36	10.95
Lend Lease Real Estate VEF III	Sep. '98-Sep. '02	17	3.66	5.32	0.49	1.79	1.29	27.87
Lend Lease Real Estate YCP II	Sep. '96-Sep. '02	25	1.33	4.65	0.05	1.78	1.36	19.92
PM Realty Advisors Inc Land Income	Mar. '93-Mar. '02	37	3.18	4.31	0.48	1.04	1.08	16.83
PM Realty Advisors Inc Separate Acct 4	Sep. '93-Mar. '02	35	2.78	1.29	1.26	1.22	1.21	1.51
Prudential RE Investors SPF-I	Jun. '90-Sep. '00	42	2.63	1.62	0.88	0.16	0.26	6.26
RREEF Funds REIT I	Mar. '95-Mar. '02	29	2.85	0.91	1.79	1.64	1.35	0.77
RREEF Funds RREEF Apt I	Sep. '89-Mar. '02	51	2.69	2.35	0.62	0.20	0.30	4.10
RREEF Funds RREEF MA/E I	Mar. '85-Sep. '00	63	1.65	2.02	0.14	0.22	0.36	3.97
RREEF Funds RREEF MA/E V	Dec. '86-Sep. '00	56	1.81	2.05	0.24	0.19	0.31	4.13
Sarofim Realty Advisors Sarofim Inv.	Mar. '85-Sep. '00	63	1.97	3.33	0.18	0.22	0.36	6.76
Sarofim Realty Advisors Value Added	Jun. '93-Dec. '02	38	3.77	3.32	0.83	1.11	1.10	10.73
Sentinel Realty Partners II	Mar. '90-Dec. '02	52	2.95	2.11	0.86	0.24	0.36	7.65
Sentinel Realty Partners III	Dec. '94-Dec. '02	33	2.49	1.19	1.14	1.60	1.33	1.55
Sentinel Realty Partners IV	Jun. '98-Dec. '02	19	2.79	1.43	1.24	1.71	1.40	2.92
UBS Brinson Realty Invest	Mar. '88-Sep. '00	51	2.35	2.93	0.35	0.17	0.27	5.66

Table 1, continued

1	2	3	4	5	6	7	8	9
Panel B. Open-End Funds	**Dates**	**N**	**Average Return**	**Standard Deviation**	**CREF Sharpe Ratio**	**NPI Sharpe Ratio**	**ALL CREF Sharpe Ratio**	**CREF Tracking Error**
AEW Capital Management LPComl Mtg	Sep. '96-Dec. '02	26	3.05	2.70	0.73	1.76	1.41	7.15
AEW Capital Management LPDevelopmental	Mar. '85-Sep. '00	63	-0.20	4.56	-0.34	0.22	0.36	16.64
AEW Capital Management LPPrivate Debt	Sep. '96-Dec. '02	26	2.91	2.37	0.77	1.76	1.41	5.13
AEW Capital Management LPPrivate Equity	Sep. '96-Dec. '02	26	3.47	1.89	1.26	1.76	1.41	2.93
AEW Capital Management LPPublic Equity	Sep. '96-Dec. '02	26	2.98	6.49	0.29	1.76	1.41	43.92
American Realty Advisors Separate Acct	Mar. '93-Dec. '02	40	2.81	1.72	1.01	1.08	1.10	3.01
ASB Capital Management Real Estate Fund	Mar. '88-Dec. '02	60	1.71	0.93	0.51	0.25	0.37	1.31
ASB Capital Management Separate Acct	Mar. '88-Sep. '02	59	1.67	1.06	0.40	0.24	0.35	2.50
Henderson Investors RESA US Profile	Mar. '85-Sep. '02	71	1.76	1.94	0.24	0.28	0.42	2.25
L&B Realty Advisors Inc Council Fund	Sep. '89-Sep. '00	45	1.72	2.64	0.17	0.14	0.25	5.73
Lend Lease Real Estate PRIME Prop Fund	Mar. '85-Sep. '02	71	1.62	1.92	0.17	0.28	0.42	1.37
PM Realty Advisors Inc Separate Acct 1	Mar. '91-Dec. '01	44	1.87	1.57	0.46	0.28	0.37	2.53
PM Realty Advisors Inc Separate Acct 2	Mar. '91-Mar. '02	45	0.76	4.64	-0.08	0.29	0.38	15.18
Prudential RE Investors PRISA	Mar. '85-Dec. '02	72	1.65	2.20	0.17	0.29	0.44	1.88
Prudential RE Investors PRISA II	Mar. '85-Dec. '02	72	2.33	2.30	0.45	0.29	0.44	3.92
Prudential RE Investors UMA	Sep. '87-Dec. '02	62	2.23	1.95	0.51	0.27	0.38	7.63
Sentinel RE Corp Sentinel RE Fund	Mar. '85-Dec. '02	72	1.81	3.30	0.16	0.29	0.44	9.37
SSR Realty Advisors Tower Fund	Mar. '85-Dec. '01	68	2.05	1.40	0.51	0.26	0.39	1.65
TimesSquare Capital Mgmt RE Fund	Mar. '85-Dec. '02	72	1.71	2.25	0.19	0.29	0.44	3.35
UBS Brinson Realty InvestParticipating	Mar. '85-Dec. '02	72	2.03	2.02	0.37	0.29	0.44	1.76
UBS Brinson Realty RE Separate Acct	Mar. '85-Dec. '02	72	1.92	2.27	0.28	0.29	0.44	1.71
UBS Brinson Realty Union Separate Acct	Mar. '85-Dec. '02	72	2.24	1.84	0.52	0.29	0.44	2.16
Union Labor Life Ins MSA J	Mar. '85-Dec. '02	72	2.22	1.27	0.73	0.29	0.44	3.96

Table 2
Downside Risk Statistics: 1985-2002

Results of performance tests are reported, after controlling for downside risk. Downside risk is reported in the second column and is defined as the semi-standard deviation for the CREF (reported in percent per calendar quarter). The Downside CREF Sharpe Ratio is reported in the third column and is defined as the mean excess return divided by the CREF's downside risk. The Downside Sharpe Ratio for the NPI computed over the reporting period for each CREF is reported in the fourth column. Downside Tracking Error is presented in the fifth column and is defined as the square root of $\sum(R_i - R_{NPI})^2/(N-1)$, computed over all observations in which $R_i < R_{NPI}$ and where N is the number of quarters in which $R_i < R_{NPI}$. The percentage of quarters in which the CREF beat the NPI is reported in the final column.

1	2	3	4	5	6
Panel A. Closed-End Funds	**Downside Risk**	**CREF Sortino ratio**	**NPI Sortino ratio**	**CREF Downside Tracking Error**	**Percentage outperformance**
AEW Capital Management LPAEW Partners I	2.72	0.87	1.75	2.34	0.44
AEW Capital Management LPAEW Partners L	5.45	0.41	3.47	5.06	0.53
AEW Capital Management LPCopley Fund	7.30	-0.11	0.14	5.80	0.42
AEW Capital Management LPCopley Fund I	2.45	0.36	0.16	2.12	0.65**
AEW Capital Management LPCopley Investors	8.51	-0.01	0.15	5.84	0.54
Clarion Partners Direct Equity	2.61	0.57	0.22	1.74	0.67**
Hearthstone Advisors Hearthstone	13.29	0.59	0.95	26.73	0.90**
Heitman Capital Mgmt Endowment & Found. III	5.70	0.01	0.21	3.29	0.45
Heitman Capital Mgmt Endowment & Found II	2.26	0.29	0.12	2.27	0.53
Heitman Capital Mgmt Group Trust I	4.28	0.18	0.10	3.00	0.52
Heitman Capital Mgmt Group Trust IV	5.88	0.02	0.17	4.17	0.34**
Heitman Capital Mgmt Group Trust V	3.31	0.22	0.21	2.41	0.57
Heitman Capital Mgmt HREF I	8.81	-0.14	0.15	5.41	0.30**
Heitman Capital Mgmt HREF II	5.10	-0.01	0.14	3.61	0.47
Heitman Capital Mgmt HREF IV	3.53	0.00	0.18	3.08	0.51
Heitman Capital Mgmt HREF V	2.20	0.38	0.50	2.40	0.48
Henderson Investors CASA Group	1.25	2.05	1.26	1.26	0.70**
INVESCO Inc Direct Equity	2.93	0.50	0.19	4.60	0.81**
L&B Realty Advisors Inc Property Fund I	5.59	0.01	2.27	3.17	0.37**
L&B Realty Advisors Inc Separate Acct	2.38	0.47	0.16	1.53	0.48
L&B Realty Inv Program	3.18	0.33	0.13	3.40	0.31*
L&B Realty Property Fund III	7.13	0.04	0.17	3.09	0.49
L&B Realty Property Fund IV	2.56	0.25	0.25	2.34	0.51

Table 2, continued

1	2	3	4	5	6
Panel A. Closed-End Funds	**Downside Risk**	**CREF Sortino ratio**	**NPI Sortino ratio**	**CREF Downside Tracking Error**	**Percentage outperformance**
Lend Lease Real Estate Fund C	2.46	0.60	1.73	2.15	0.42
Lend Lease Real Estate InCore Mortgage	1.57	0.84	0.14	1.85	0.45
Lend Lease Real Estate InCore Property	2.82	0.25	1.79	2.78	0.43
Lend Lease Real Estate VEF II	2.42	0.71	1.79	1.85	0.28**
Lend Lease Real Estate VEF III	2.52	1.04	1.42	1.64	0.41
Lend Lease Real Estate YCP II	3.45	0.06	1.79	3.48	0.16**
PM Realty Advisors Inc Land Income	3.42	0.60	0.88	3.14	0.51
PM Realty Advisors Inc Separate Acct 4	0.74	2.20	1.21	0.85	0.66*
Prudential RE Investors SPF-I	1.29	1.11	0.12	2.09	0.74**
RREEF Funds REIT I	0.75	2.19	1.80	0.59	0.52
RREEF Funds RREEF Apt I	2.40	0.61	0.16	1.40	0.76**
RREEF Funds RREEF MA/E I	2.39	0.12	0.15	1.84	0.44
RREEF Funds RREEF MA/E V	2.92	0.17	0.14	2.20	0.54
Sarofim Realty Advisors Sarofim Inv	3.63	0.17	0.69	2.54	0.57
Sarofim Realty Advisors Value Added	2.19	1.27	0.26	1.20	0.69**
Sentinel Realty Partners II	1.17	1.54	0.19	0.92	0.69**
Sentinel Realty Partners III	0.67	2.02	1.69	0.97	0.39**
Sentinel Realty Partners IV	0.77	2.31	1.57	0.79	0.37**
UBS Brinson Realty Invest	2.40	0.43	0.12	1.52	0.57

Table 2, continued

1	2	3	4	5	6
Panel B. Open-End Funds	**Downside Risk**	**CREF Sortino ratio**	**NPI Sortino ratio**	**CREF Downside Tracking Error**	**Percentage outperformance**
AEW Capital Management LPComl Mtg	1.88	1.04	1.82	1.75	0.50
AEW Capital Management LPDevelopmental	6.44	-0.24	0.15	4.82	0.32**
AEW Capital Management LPPrivate Debt	2.02	0.90	1.82	1.46	0.46
AEW Capital Management LPPrivate Equity	1.35	1.75	1.82	0.73	0.62
AEW Capital Management LPPublic Equity	6.55	0.29	1.82	6.48	0.50
American Realty Advisors Separate Acct	0.79	2.21	0.99	0.77	0.65**
ASB Capital Management Real Estate Fund	1.04	0.45	0.19	0.89	0.43
ASB Capital Management Separate Acct	0.73	0.58	0.18	1.19	0.42
Henderson Investors RESA US Profile	2.62	0.18	0.20	1.65	0.52
L&B Realty Advisors Inc Council Fund	2.54	0.18	0.11	2.17	0.47
Lend Lease Real Estate PRIME Property Fund	2.57	0.12	0.20	1.40	0.49
PM Realty Advisors Inc Separate Acct 1	2.45	0.29	0.21	1.31	0.52
PM Realty Advisors Inc Separate Acct 2	9.67	-0.04	0.22	4.63	0.40
Prudential RE Investors PRISA	2.80	0.13	0.21	1.62	0.54
Prudential RE Investors PRISA II	2.72	0.38	0.21	2.56	0.74**
Prudential RE Investors UMA	1.91	0.52	0.20	1.69	0.52
Sentinel RE Corp Sentinel RE Fund	7.53	0.07	0.21	4.08	0.58
SSR Realty Advisors Tower Fund	1.49	0.48	0.19	0.84	0.53
TimesSquare Capital Mgmt Open-End RE Fund	3.33	0.13	0.21	2.41	0.56
UBS Brinson Realty InvestParticipating	2.52	0.30	0.21	1.36	0.63**
UBS Brinson Realty RE Separate Acct	2.65	0.24	0.21	1.36	0.57
UBS Brinson Realty Union Separate Acct	2.11	0.45	0.21	1.32	0.68**
Union Labor Life Ins MSA J	1.21	0.77	0.21	1.36	0.56

* significantly different from 50% at the 0.10 level
** significantly different from 50% at the 0.05 level

Table 3
CREF Portfolio and Index Performance: 1985-2002

Descriptive and performance data for CREF portfolios and indices are provided. "All", "Closed", and "Open" are equally-weighted portfolios of all sampled CREFs, closed-end CREFs, and open-end CREFs, respectively. The remaining rows present the descriptive statistics for the NPI geographic region indices (East, South, Midwest, and West) and NPI property indices (Apartments, Industrial, Office, and Retail), respectively. Returns are reported in percent per calendar quarter. The mean and standard deviation for the quarterly Treasury bill return was 1.29% and 0.43%, respectively, during the sample period.

Portfolio or Index	Mean Return	Standard Deviation	Sharpe Ratio	Downside Risk	Sortino Ratio	Tracking Error	Downside Tracking Error	Percentage outperformance
All CREFS	2.01	1.64	0.44[aa]	2.20	0.33	0.67	0.48	0.71[bb]
Closed	2.14	2.05	0.42	2.24	0.38	1.21	0.85	0.67[bb]
Open	1.85	1.37	0.41[a]	1.87	0.30	0.65	0.51	0.45
Indices:								
NPI Composite	1.75	1.56	0.29	2.14	0.21	---	---	
East	1.93	1.83	0.35	2.51	0.26	0.63	0.43	0.60
South	1.44	1.37	0.11[aa]	1.73	0.09	0.92	1.00	0.33[bb]
Midwest	1.78	1.60	0.30	1.95	0.25	0.77	0.63	0.46
West	1.81	1.83	0.28	2.26	0.23	0.58	0.70	0.63[bb]
Apartments	2.20	1.17	0.78[aa]	1.47	0.62	1.03	0.56	0.69[bb]
Industrial	1.98	1.61	0.43[aa]	2.16	0.32	0.58	0.41	0.64[bb]
Office	1.34	2.32	0.02[aa]	2.71	0.02	1.04	1.14	0.32[bb]
Retail	1.97	1.56	0.44	1.59	0.43	1.18	0.96	0.56

[a] Sharpe ratio is significantly different from the NPI Sharpe ratio at the 0.10 level.
[aa] Sharpe ratio is significantly different from the NPI Sharpe ratio at the 0.05 level.
[bb] Percentage performance is significantly different from 50% at the 0.05 level.

Table 4
Single Index Tests: 1985-2002

Alphas, betas and R^2s from the regression $R_{i,t} - R_{f,t} = \alpha_i + \beta_i(R_{RE,t} - R_{f,t}) + \varepsilon_{i,t}$ are presented, where $R_{i,t}$ is the CREF quarterly return, R_{ft} is the 90-day Treasury bill return, and $R_{NPI,t}$ is the quarterly return on the NPI. Significant positive (negative) α indicates superior (inferior) performance relative to the real estate benchmark. Alpha is reported in percent per calendar quarter. The results for the closed-end CREFs (n=42) are presented in Panel A and those for the open-end CREFs (n=23) are provided in Panel B. The CREF portfolio results are summarized in Panel C.

Panel A. Closed-End Funds	**α**	**β**	**R^2**
AEW Capital Management LPAEW Partners I	-0.85	1.99*	0.13
AEW Capital Management LPAEW Partners L	-4.94	3.69*	0.24
AEW Capital Management LPCopley Fund	-1.49**	2.08**	0.34
AEW Capital Management LPCopley Fund I	0.64**	0.66**	0.26
AEW Capital Management LPCopley Investors	-1.00*	2.56**	0.51
Clarion Partners Direct Equity	0.92**	1.09**	0.48
Hearthstone Advisors Hearthstone	6.26	1.31	0
Heitman Capital Mgmt Endowment & Found III	-0.59*	1.44**	0.42
Heitman Capital Mgmt Endowmt Found II	0.46	0.65**	0.17
Heitman Capital Mgmt Group Trust I	0.08	1.85**	0.53
Heitman Capital Mgmt Group Trust IV	-0.59	2.06**	0.38
Heitman Capital Mgmt Group Trust V	0.35	0.91**	0.34
Heitman Capital Mgmt HREF I	-1.82**	1.73**	0.30
Heitman Capital Mgmt HREF II	-0.46	1.26**	0.32
Heitman Capital Mgmt HREF IV	-0.20	0.46**	0.10
Heitman Capital Mgmt HREF V	0.57	0.31	0.03
Henderson Investors CASA Group	3.08**	-0.40	0.02
INVESCO Inc Direct Equity	1.37**	0.27	0.02
L&B Realty Advisors Inc Property Fund I	-0.46	1.55**	0.42
L&B Realty Advisors Inc Separate Acct	0.67*	1.08**	0.24
L&B Realty Inv Program	0.79	0.16	0
L&B Realty Property Fund III	-0.20	1.22**	0.33
L&B Realty Property Fund IV	0.48	0.38**	0.08
Lend Lease Real Estate Fund C	-1.33	1.75**	0.29
Lend Lease Real Estate InCore Mortgage	1.76**	-0.30	0.01
Lend Lease Real Estate InCore Property	0.44	0.71*	0.13
Lend Lease Real Estate VEF II	-3.65**	3.31**	0.42
Lend Lease Real Estate VEF III	0.82	1.27	0.02
Lend Lease Real Estate YCP II	-5.17**	3.32**	0.28
PM Realty Advisors Inc Land Income	0.24	1.56**	0.12
PM Realty Advisors Inc Separate Acct 4	0.92	0.56**	0.17
Prudential RE Investors SPF-I	1.36**	0.21	0.06
RREEF Funds REIT I	0.90**	0.51**	0.23
RREEF Funds RREEF Apt I	1.12**	0.93**	0.49
RREEF Funds RREEF MA/E I	0.08	0.55**	0.18
RREEF Funds RREEF MA/E V	0.32	0.54**	0.19
Sarofim Realty Advisors Value Added	0.60	1.81**	0.27
Sentinel RE Corp Sentinel RE Fund	0.07	1.00**	0.20
Sentinel Realty Partners II	1.68**	0.30*	0.06
Sentinel Realty Partners III	0.90**	0.33	0.05
Sentinel Realty Partners IV	2.29**	-0.35	0.02
UBS Brinson Realty InvestAetna Inst	0.72**	1.07**	0.41

Table 4, continued

Panel B. Open-End Funds	α	β	R^2
AEW Capital Management LPComl Mtg	1.19	0.48	0.02
AEW Capital Management LPDevelopmental	-2.18**	1.70**	0.39
AEW Capital Management LPPrivate Debt	0.75	0.67	0.04
AEW Capital Management LPPrivate Equity	-0.00	1.48**	0.34
AEW Capital Management LPPublic Equity	4.60	-1.69	0.04
American Realty Advisors Separate Acct	1.06**	0.58**	0.10
ASB Capital Management Real Estate Fund	0.30**	0.41**	0.56
ASB Capital Management Separate Acct	0.32**	0.27**	0.16
Henderson Investors RESA US Profile	0.12	0.78**	0.40
L&B Realty Advisors Inc Council Fund	0.27	0.68**	0.23
Lend Lease Real Estate PRIME Prop Fund	-0.11	0.96**	0.62
PM Realty Advisors Inc Separate Acct 1	0.48**	0.47**	0.31
PM Realty Advisors Inc Separate Acct 2	-1.21**	1.58**	0.37
Prudential RE Investors PRISA	-0.12	1.06**	0.59
Prudential RE Investors PRISA II	0.68**	0.80**	0.30
Prudential RE Investors UMA	1.08**	-0.20	0.03
Sentinel RE Corp Sentinel RE Fund	0.07	1.00**	0.20
SSR Realty Advisors Tower Fund	0.47**	0.59**	0.42
TimesSquare Capital Mgmt Open-End RE Fund	0.02	0.885**	0.35
UBS Brinson Realty InvestParticipating	0.26	1.06**	0.61
UBS Brinson Realty RE Separate Acct	0.06	1.27**	0.71
UBS Brinson Realty Union Separate Acct	0.57**	0.84**	0.47
Union Labor Life Ins MSA J	0.91**	0.04	0.01

Panel C. CREF Portfolios and Indices	α	β	R^2
All CREFS	0.27**	0.98**	0.85
Closed	0.35**	1.11**	0.69
Open	0.20**	0.80**	0.82
TE1	0.25**	0.78**	0.85
TE5	-0.59**	2.04**	0.47
NPI Indices:			
East	0.13*	1.12**	0.90
South	-0.20*	0.77**	0.69
Midwest	0.08	0.89**	0.76
West	0.02	1.09**	0.90
Apt	0.63**	0.64**	0.63
Industrial	0.25**	0.96**	0.89
Office	-0.60**	1.42**	0.90
Retail	0.36**	0.70**	0.50

* significant at the 0.10 level
** significant at the 0.05 level

Table 5

Tests Over Varying Market Conditions: 1985-2002

Alphas, betas, t-statistics, and R^2s from regressions run over varying real estate market conditions are reported in Panels A, B, and C. In Panels A and B, statistics are derived from the regression: $r_{pt} = \alpha_{po} + \alpha_{p1} D_t + \beta_{po} r_{NPI,t} + \beta_{p1} r_{NPI,t} D_t + \varepsilon_{it}$, where r_{pt} is the excess return on the portfolio of sampled CREFs (equally-weighted CREF portfolio return minus the 90-day treasury bill return) in quarter t and $r_{NPI,t}$ is the excess return on the NPI in quarter t. In Panel A, D_t equals one for quarters in which the NPI return is positive and equals zero otherwise. In Panel B, D_t equals one for quarters in which the NPI excess return is positive and equals zero otherwise. In Panel C, statistics are derived from the regression: $r_{pt} = \alpha_{po} + \alpha_{p1} D_{1t} + \alpha_{p2} D_{2t} + \beta_{po} r_{NPI,t} + \beta_{p1} r_{NPI,t} D_{1t} + \beta_{p2} r_{NPI,t} D_{2t} + \varepsilon_{it}$, where D_{1t} equals one for quarters in which the NPI return exceeds its mean plus one standard deviation and D_{2t} equals one for quarters in which the NPI return exceeds its mean less one standard deviation.

Panel A: Up and Down: NPI

	Estimate	t-statistic
α_o	0.76	1.89*
α_1	0.92	2.21**
β_o	0.78	5.63**
β_1	0.10	0.61
R^2	0.82	

Panel B: Up and Down: NPI minus Treasury Bill return

	Estimate	t-statistic
α_o	1.67	7.21**
α_1	-0.15	-0.49
β_o	1.01	9.08**
β_1	-0.02	-0.12
R^2	0.80	

Panel C: Substantially Up and Down

	Estimate	t-statistic
α_o	1.75	13.95
α_1	-0.63	-2.90
α_2	-0.99	-1.82
β_o	0.73	5.63
β_1	0.49	1.05
β_2	0.04	0.26
R^2	0.82	

Table 6
Tests of Persistence: 1986-2002

CREFs are sorted based on compounded quarterly return for each year and classified into Quintiles. CREFs with highest past year (year *t-1*) returns are classified in Quintile 1 and CREFs with the lowest past year returns are classified in Quintile 5. The funds are re-sorted every year. Equally-weighted quarterly returns are calculated for each Quintile in the year after the sorting. Column 2 reports the quarterly excess return in year t for each Quintile. The t-statistics are presented in parentheses.

Quintile	Quarterly Excess Return	Standard Deviation	Alpha	Beta	R^2
1	-0.25% (-0.76)	2.75%	-0.86% (-4.00)	1.39 (10.44)	0.63
2	0.34% (1.53)	1.85%	-0.13% (-1.46)	1.09 (19.47)	0.85
3	0.65% (3.11)	1.72%	0.20% (2.57)	1.03 (21.08)	0.87
4	1.06% (5.93)	1.50%	0.72% (6.74)	0.77 (11.58)	0.67
5	1.67% (5.08)	2.71%	1.34% (4.33)	0.76 (3.92)	0.19
5 minus 1	1.92% (4.88)	3.25%	2.19% (5.60)	-0.64 (2.61)	0.09

Table 7
CREF Sector Allocation Summary

This table presents the effective mix for CREF portfolios. Panel A summarizes the results of the regional model, estimated by $R_{it} = b_{iE}R_{EAST,t} + b_{iS}R_{SOUTH,t} + b_{iMW}R_{MIDWEST,t} + b_{iW}R_{WEST,t} + \varepsilon_{it,}$ where each R_{it} is the return for quarter t for CREF portfolio *i* and on the East, South, Midwest, and West NPI regional subsets. In each regression, the slopes are constrained to sum to 100% and to be nonnegative. The slopes represent the estimated or effective mix for each portfolio. Panel B provides the performance results for the property index model, estimated by $R_{it} = b_{iO}R_{OFFICE,t} + b_{iA}R_{APT,t} + b_{iR}R_{RETAIL,t} + b_{iI}R_{IND,t} + u_{it,,}$ where each R_{it} is the return for quarter t for CREF portfolio *i* and on the Apartment, Office, Industrial, and Retail NPI property type subsets. The effective mix weights are reported in columns 2 through 5. Column 6 provides the Effective Mix return defined as the weighted average of the mean sector returns, using the estimated slopes, *b*, as the weights. Column 7 provides the differential return for each CREF portfolio versus the NPI return. These entries equal the overall differential performance of the CREF portfolio. Column 8 provides the contribution of sector allocation to the overall relative performance of the CREF portfolio. Column 9 provides the contribution of Individual Property Selection to the overall differential performance of the CREF portfolio. Column 10 reports the random component. Together, the entries in Columns 8 – 10 sum to the overall differential performance of the CREF portfolio. Columns 6-10 are reported in percent per calendar quarter.

Panel A: Regional Sector Allocation[a]

1 **Panel A. Portfolio (mean return)**	2 **b_E East**	3 **b_S South**	4 **b_{MW} Midwest**	5 **b_W West**	6 **Effective Mix Return**	7 **CREF minus NPI return**	8 **Sector Allocation Component**	9 **Property Selection Component**	10 **Random Component**
NPI (1.75%)	0.264	0.212	0.176	0.348	1.755	-----	-----	-----	
ALL CREF (2.01%)	0.462	0.135	0.078	0.324	1.808	0.26	0.053	0.202	0.005
CLOSED (2.14%)	0.589	0.016	0.091	0.304	1.869	0.39	0.114	0.271	0.005
OPEN (1.85%)	0.359	0.274	0.041	0.327	1.750	0.10	-0.005	0.100	0.005

Table 7, continued

Panel B: Property Allocation[b]

1 PORTFOLIO	2 b_A APT	3 b_{IND} INDUSTRY	4 b_O OFFICE	5 b_R RETAIL	6 Effective Mix Benchmark	7 CREF minus NPI return	8 Sector Allocation Component	9 Property Selection Component	10 Random Component
NPI (1.75%)	0.157	0.171	0.385	0.287	1.766	-----	-----	-----	
ALL CREF (2.01%)	0.196	0.222	0.266	0.316	1.851	0.26	0.085	0.159	0.016
CLOSED (2.14%)	0.172	0.025	0.340	0.463	1.796	0.39	0.030	0.344	0.016
OPEN (1.85%)	0.216	0.505	0.128	0.151	1.946	0.10	0.180	-0.096	0.016

[a] Mean quarterly returns for East, South, Midwest, and West regions were 1.928%, 1.44%, 1.775%, and 1.806%, respectively.
[b] Mean quarterly returns for Apartment, Industrial, Office, and Retail property types were 2.204%, 1.983%, 1.336%, and 1.973%, respectively.