Real Estate Risk and Hedge Fund Returns[1]

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Abstract

Although the performance of hedge funds across a wide range of investment strategies is well documented, we explore a new investment dimension relating hedge fund exposure to the real estate market. Using fund level data from 1994 to 2012 from a major hedge fund data vendor, we identify 1,238 hedge funds as having significant exposure to direct or securitized real estate investments. We document that funds with significant real estate exposure have lower incentive fees, similar account liquidity, lower leverage, and higher high water mark levels. Compared to hedge funds that have exposure to securitized real estate, funds that have exposure to direct real estate have higher leverage, longer redemption periods, lower high water marks, and lower minimum investment requirements. Finally, we test for the economic impact of real estate exposure and show that funds with significant real estate investment do not significantly outperform funds that do not have real estate exposure.

1. Introduction

One of the interesting aspects of the hedge fund industry is the fundamental problem of asymmetric information between the funds and their investors about the actual investments contained in the funds' portfolios. Fund managers have incentives to hide or mask their investment positions in order to prevent competitors from gaining an advantage in trading. However, investors are often reluctant to invest without information about how the manager plans to deploy the investor's funds. As a result, hedge fund managers often provide minimal information about their investment allocations and positions by utilizing generic "strategy" descriptions. Furthermore, the hedge fund industry has created a number of strategy classifications, such as Convertible Arbitrage, Dedicated Short Bias, Emerging Markets, Equity Market Neutral, Event Driven Hedge, Event Driven Distressed, Event Driven Multi-Strategy, Event Driven Risk Arbitrage, Fixed Income Arbitrage, Global Macro, Long Short Equity, Managed Futures, and Multi-Strategy, with corresponding indexes in an effort to help investors evaluate and benchmark manager performance.[2]

A large literature has developed surrounding the analysis of hedge funds with respect to these various strategy descriptions as well as investment styles. Traditionally, researchers focus on developing asset-pricing factor models as a means of exploring the return variability of hedge funds in order to understand their risk-reward relation. For example, early work by Fung and Hsieh (1997, 2001) and Agarwal and Naik (2004) incorporate option market factors into the traditional linear multi-factor asset pricing model to explore the sensitivity of hedge fund returns to dynamic risk. More recently, Sadka (2010) uses the similar multi-factor pricing model to assess the extent that market-wide liquidity is an undiversifiable risk factor.

Interestingly, real estate is not listed as one of the common hedge fund investment strategies and to date, no one has examined whether a market-wide real estate risk factor exists. Yet, U.S. commercial

[2] The Appendix provides a description of these strategies.

real estate is a significant asset class valued at approximately $11.5 trillion as of the end of 2009.[3] In comparison, the value of all publicly traded shares at the end of 2009 was approximately $15.1 trillion.[4] As a result, real estate is often touted as having significant benefits for portfolio diversification and inflation hedging purposes. For example, beginning with Ibbotson and Siegel (1984) a lengthy literature examines the diversification benefits in the context of modern portfolio theory through the correlation between real estate investments and other asset classes.[5] In addition, real estate investments during the previous decade significantly outperformed broader stock indexes. For example, over the period from 2000 to 2010, real estate investment trusts (REITs) had a compound annual total return of 10.6% compared to a -0.95% compound annual total return for the S&P500.[6] Figure 1 shows the performance of hedge funds, real estate investment trusts, and the broader stock market over the period from 2000 to 2012. The figure shows that even with the significant REIT correction in 2009, the cumulative performance of securitized real estate outperforms the general hedge fund index and the broader stock market. Furthermore, comparing the returns on the generic hedge fund index with the returns on the NCREIF property index (NPI) indicates a low level of correlation.

Given the size of the real estate market and the low historical correlations of real estate assets with other investments, a natural question is whether hedge funds invest in real estate assets and if so, do these investments give fund managers a performance edge. To address these questions, we develop an empirical method that identifies funds with significant exposure to the real estate market, either direct investment as captured by the NCREIF NPI or Transaction Based Index (TBI) or indirect real estate investment as captured by sensitivity to real estate investment trusts as measured by the NAREIT index. Our empirical strategy finds that between 1994 and 2012, 1,238 out of 3,669 funds had significant exposure to real estate assets. Using the bootstrap methodology of Kosowki et al. (2006, 2007), we

[3] See Florance et al. (2010) for a detailed estimation of the value of total U.S. commercial real estate property.
[4] CIA *The World Factbook*, https://www.cia.gov/library/publications/the-world-factbook/geos/us.html.
[5] See Sirmans and Sirmans (1987), Liu, et al. (1990), Chan et al. (1990), Webb, Miles and Guilkey (1992), Grauer and Hakansson (1995), and Peterson and Hsieh (1997) among many others for evidence on the role of real estate in asset allocation and modern portfolio theory.
[6] See *The Role of Real Estate in Weathering the Storm*, National Association of Real Estate Investment Trusts: http://www.reit.com/DataAndResearch/ResearchResources/~/media/PDFs/Weathering-The-Storm-Special-Report-2012.ashx.

confirm that our assignment of funds into real estate and non-real estate portfolios. We then investigate the characteristics of funds based on their real estate exposures. First, we control for various risk characteristics to ensure comparison across funds that differ only through varying levels of real estate exposure. Through a normed distance based matching algorithm we identify 1,235 real estate and non-real estate hedge funds. The matching procedure ensures that the hedge funds have differential real estate risk exposure but otherwise similar risk characteristics. As a result, any inference can be attributed to the level of real estate risk. We show that non-real estate funds are systematically clustered into Long/Short Equity Hedge and Managed Futures investment strategies while real estate funds are not concentrated in any specific strategy classification.

Next, our results indicate that funds with significant real estate exposure have lower incentive fees, lower leverage, and higher high water mark levels. Also, when compared to hedge funds that have exposure to securitized real estate, funds that have exposure to the direct real estate market have higher leverage, longer redemption periods, lower high water marks, and lower minimum investment requirements. These results are consistent with the theory that fund governance structures actively impact individual fund investment allocations. Finally, we compare fund returns and find that funds with significant real estate exposure do not outperform funds that do not have real estate exposure. Given the correlation between fund governance structure and performance, our study has identified one potential channel as a source for this performance.

Our paper proceeds as follows: the next section discusses the hedge fund data followed by our empirical strategy for identifying funds with real estate exposure. Next, through an individual fund level and index level analysis we examine the robustness of the real estate factor methodology in successfully measuring risk from the real estate market. We then proceed to examine the characteristics of funds that have real estate exposure and finally provide evidence concerning the performance of real estate and non-real estate funds.

2. Data

We identify hedge funds that follow a real estate investment strategy using hedge fund information contained in the Lipper TASS database over the period from 1994 to 2012. The TASS database tracks hedge funds that are operating (or "Live") as well as funds that no longer report (or "Graveyard"). By reporting on both operating and dead funds, TASS reduces the survivorship bias inherent in other hedge fund data providers. The TASS database allows us to track the monthly returns on funds net of all fees (management, incentive and other expenses).

TASS classifies individual hedge funds into ten strategy categories: convertible arbitrage, dedicated short bias, emerging markets, equity market neutral, event driven, fixed income arbitrage, fund of funds, global macro, long-short equity, managed futures, and multi-strategy. Following Sadka (2010), we retain the category "fund-of-funds" in the analysis since they are possible targets of investment by real estate hedge funds. Figure 2 plots the frequency distribution of hedge funds within each of these strategies. Interestingly, the most common investment strategy by far is the fund-of-funds followed by the long/short equity hedge strategy. Sadka (2010) notes that cross-sectional variation in returns exists across these investment styles and thus we use this variation in identifying a real estate market risk factor. We focus on the period from January 1994 onwards to mitigate the effect of survivorship bias. Furthermore, to account for backfill and selection bias we exclude fund data within the first 24 months of its introduction to the database. To ensure meaningful regressions we exclude funds that have less than 24 quarters of return observations and our final hedge fund sample includes 3,669 funds.

In addition to individual fund level investment strategy data, TASS reports individual fund characteristics that indicate whether the fund uses leverage or invests in other funds. For funds that use leverage, TASS further reports the use of futures, derivatives, margin borrowing, or foreign exchange credit. TASS also reports each fund's minimum investment requirement, management and performance fees, high water mark, average and maximum leverage utilized, and whether the fund's principal has personal capital invested. Furthermore, TASS reports on any lockup and redemption period mandates allowing one to infer the fund's liquidity position. Finally, the TASS database contains a detailed description of each individual fund's investment strategy. Overall, the dataset provides a unique snapshot

of the net-of-fee performance and characteristics of hedge funds that invest in a range of diverse strategies.

While the strategy categorizations employed by TASS are relatively broad and cover a variety of investment alternatives, TASS does not include an explicit real estate investment strategy. Yet, growth in the real estate market and in particular, growth in securitized claims on real estate (through real estate investment trusts (REITs) and mortgage-backed securities (MBS/CMBS)) suggest that hedge fund managers have ample opportunities to invest in real estate assets within the TASS style categories.

3. Identification of real estate hedge funds

We develop a real estate market factor methodology that builds on the hedge fund factor analysis of Fung and Hsieh (2004). Our goal is to first identify individual funds that utilize real estate investments (as revealed by their sensitivity to various real estate market factors) as part of their investment strategy and then second to examine the variation in real estate and non-real estate hedge fund returns. Fung and Hsieh (2002, 2004) show that the variation in hedge fund returns can be explained by a buy-and-hold strategy based on four factors capturing movements in the equity and bond markets as well as three "trend-following" factors based on the option pricing models of Black and Scholes (1973) and Merton (1973).[7] Thus, we augment their factor model to include a real estate factor as follows:

$$r_{i,t} = \alpha_i + \beta_{i,1}MKT_t + \beta_{i,2}SMB_t + \beta_{i,3}YLDCHG_t + \beta_{i,4}BAAMSTY_t + \beta_{i,5}PTFSBD_t + \beta_{i,6}PTFSFX_t + \beta_{i,7}PTFSCOM_t + \beta_{i,8}RE\_MKT_t + \varepsilon_{i,t} \quad (1)$$

where $r_{i,t}$ is the net-of-fee excess return of fund *i* in quarter *t*; *MKT* is the CRSP value-weighted return index (VWRETD) return less risk free-rate; *SMB* is a size factor represented as the spread between the returns on the Wilshire Small Cap index and the Wilshire Large Cap index; *YLDCHG* is the change in the

[7] A trend following strategy captures the payoff generated when the asset price exceeds certain thresholds. Fung and Hsieh (2001) model the payoff of a trend following strategy through a look-back straddle that gives the owner a right to purchase an asset at the lowest price over the life of the option, along with a put option with a right to sell at the highest price during the life of the option. Hence, the monthly return of a trend following strategy is the payoff due to the difference between the highest and lowest price of the asset less the price of the look-back straddle. The three trend following risk factors capture movements in the bond, currency and commodity markets.

10-year treasury constant maturity yield; *BAAMTSY* is the change in the Moody's Baa yield less 10-year treasury constant maturity yield; *PTFSBD* is the return of a bond primitive trend-following strategy; *PTFSFX* is the return of a currency primitive trend-following strategy; *PTFSCOM* is the return of a commodity primitive trend-following strategy; *RE_MKT* represents a real estate market factor (defined below); α_i is the risk adjusted performance of fund *i*; and $\beta_{i,1}$,……, $\beta_{i,8}$ are the factor loadings of fund *i*.[8]

We use three proxies for the real estate market factor based on direct real estate investment (NCREIF) and indirect real estate exposure through REIT securities. Specifically, we capture real estate risk through (1) the NAREIT index that acts as a proxy for the indirect or securitized equity real estate market, and (2) the NCREIF NPI and (3) the NCREIF TBI indexes as a proxy for the returns on direct investment in institutional grade real property. The NAREIT index represents variation in the highly liquid securitized market. Hence, we use the NCREIF index to proxy for investments in the direct real estate market. Additionally, we include both the NPI and TBI based measures to account for lagged and appraisal based issues inherent in the NCREIF index.

However, to the extent that real estate investments are affected by the other equity and bond market factors, equation (1) will be over identified. Thus, we use the residual from the estimated regression equation of the real estate market excess return (NAREIT, NCREIF NPI and TBI) on Fung-Hsieh factors as our real estate market factor. Specifically, we estimate the following regression for the each real estate index:

$$RE\_INDEX_t = \delta_0 + \delta_1 MKT_t + \delta_2 SMB_t + \delta_3 YLDCHG_t + \delta_4 BAAMSTY_t + \delta_5 PTFSBD_t + \delta_6 PTFSFX_t + \delta_7 PTFSCOM_t + \varepsilon_t \quad (2)$$

where *RE_INDEX* is the excess return of the *NAREIT, NCREIF NPI* or *TBI* index. The residual represents a real estate specific component that is not explained by the general equity market and is uncorrelated with the stock market factor (*MKT*) and other Fung-Hsieh factors. We classify hedge funds that have a statistically significant coefficient on the real estate market factor (*RE_MKT*) as real estate

[8] Fung and Hsieh factor data available at: http://faculty.fuqua.duke.edu/~dah7/DataLibrary/TF-FAC.xls

hedge funds. The orthogonality of the real estate market factor ensures that our classification is not incorrectly picking up variation in other correlated factors.

Panels *A* and *B* of Table 1 report the summary statistics of our real estate factors and the Fung-Hsieh factors. We see that the average return of the stock market (CRSP VWRETD) is lower than that of the NAREIT index, implying a potential differential economic impact between portfolios comprising of the stock market and real estate market.[9] We also note that the Fung-Hsieh factors exhibit considerable variation in values over the sample time period, and could potentially explain the variation in returns of hedge funds that follow a real estate investment strategy.

Figure 3 presents the classification of hedge funds that have significant real estate factor loadings from the estimation of equation (1). Out of the 3,669 hedge funds in our sample, we find 1,238 funds have a significant loading on one of our real estate factors, and thus are classified as "real estate funds", while 2,431 have an insignificant loading on the real estate factors (and thus are classified as "non-real estate funds"). Out of the 1,238 "real estate funds" we see that 451 funds have exposure to the NCREIF NPI index only, 130 to the NCREIF TBI index only, and 383 to the NAREIT index only. Furthermore, we note that 218 hedge funds have exposure to the NCREIF NPI or TBI, indicating a high correlation between the two identification strategies. In contrast, only 75 hedge funds have exposure to the NCREIF NPI or TBI index and the NAREIT index suggesting that investment in direct real estate (NCREIF) versus securitized real estate (NAREIT) is somewhat mutually exclusive. Furthermore, only 19 funds have exposure to all three real estate indexes. Overall, our identification strategy reveals that a large number (34%) of hedge funds have exposure to the direct or indirect real estate market.

Next we turn to an analysis of the differences in returns for real estate versus non-real estate funds. Table 2 reports summary statistics of average quarterly returns of real estate hedge funds across the real estate strategy classifications. We see that our empirically identified "real estate funds" have a mean quarterly return of 1.45% (5.80% per year) while non-real estate funds had a quarterly return of

[9] NAREIT index return data obtained from REIT.com

1.91% (7.64% per year). Although real estate funds had a lower average return, we also note that they had a lower standard deviation (6.28% versus 6.77%). Examining the real estate funds based on the individual factor loading, we see that NAREIT loading hedge funds had a mean return of 1.50% per quarter (6.0% per year). In comparison, NCREIF NPI loading funds had a mean return of 1.41% per quarter (5.64% per year), and NCREIF TBI loading funds produced a quarterly return of 1.26% (5.04% per year). Figures 4 and 5 show the distribution of real estate hedge funds over time. It is interesting to note the increasing percentage of funds that load on the NCREIF index over time suggesting that over time, funds have increased their sensitivity to direct real estate investment. Initially, the number of real estate hedge funds is low but increases up to 2006, the year prior to the financial crisis in 2007 – 2008. The post crisis era experienced a significant drop in the number of hedge funds that explicitly follow a real estate investment strategy. Overall, our empirical strategy finds that a large number of hedge funds have exposure to the direct and securitized market real estate market.

4. Empirical Results on the Real Estate Factors

In this section we discuss the level of real estate exposure of hedge fund indexes created from equally weighted portfolios of individual real estate non-debt and debt related funds. Additionally, we present the cross-sectional distribution of the real estate market factor's coefficient (*t*-statistic) across individual funds for different subsets of the data. Combined, the analysis provides aggregate index level and individual fund level results that verify the efficacy of the real estate factors constructed from the NAREIT, NCREIF NPI and TBI index returns. Our analysis contrasts the percent of variation in the returns of real estate hedge funds explained by the real estate factor (NAREIT, NCREIF NPI or TBI based) against that of diversified hedge fund index returns.

4.1 Bootstrap Analysis

Fund level regressions implicitly assume normality of return data and this may result in inaccurate estimation and potential significance of the real estate market factor in the estimated model. To test for this possibility, we follow the Kosowki et al. (2006, 2007) bootstrap methodology to account for non-normality, heteroskedasticity, and serial correlation in hedge fund returns and obtain a robust distribution of the real estate market factors. Following the Kosowki et al. method, we construct a time series of pseudo–quarterly excess returns for each fund by imposing the null hypothesis of zero real estate exposure. From these pseudo returns, we then build a distribution of the real estate factor coefficients that result purely from sampling variation while imposing the null hypothesis of no real estate exposure.

In order to assess the statistical significance of the real estate market factor (*RE_MKT*) and its corresponding *t*-statistic for individual hedge funds we implement the following procedure[10]:

Step 1: Estimate the 8-factor model for each fund *i*:

$$r_{i,t} = \alpha_i + \beta_{i,1}MKT_t + \beta_{i,2}SMB_t + \beta_{i,3}YLDCHG_t + \beta_{i,4}BAAMSTY_t + \beta_{i,5}PTFSBD_t + \beta_{i,6}PTFSFX_t$$
$$+ \beta_{i,7}PTFSCOM_t + \beta_{i,8}RE\_MKT_t + \varepsilon_{i,t} \quad (3)$$

and store the *t*-statistic of the coefficient of the real estate market factor (*RE_MKT*) $\{t_{RE\_MKT}\}$ and the time series of estimated residual $\{\hat{\varepsilon}_{i,t}, t = 1, \ldots\ldots, T_i\}$[11].

Step 2: From the fund *i* residuals saved from the first step, draw a random sample with replacement to get a time series of resampled residuals $\{\hat{\varepsilon}^b_{i,t}, t = s_1^b, s_2^b, \ldots\ldots, s_{T_i}^b\}$, where $b = 1, \ldots\ldots B$ (in all our bootstrap tests, we set $B = 1000$). Each sample is drawn such that it has the same number of residuals i.e. the same number of time periods T_i as the original sample for each fund *i*. Then for each bootstrap iteration we construct a time series of quarterly excess returns for each fund by imposing the null hypothesis of zero

[10] We evaluate and sort based on *t*-statistics instead of the actual coefficient, as it normalizes the estimated coefficient and hence corrects for spurious outliers.
[11] *t*-statistics are based on heteroscedasticity and autocorrelation consistent standard error estimates.

exposure to the real estate market factor or hedge funds which do not load on the real estate market factor ($\beta_{i,8} = 0$, or equivalently $t_{RE\_MKT} = 0$)[12],

$$r_{i,t}^{b} = \alpha_i + \hat{\beta}_{i,1} MKT_t + \hat{\beta}_{i,2} SMB_t + \hat{\beta}_{i,3} YLDCHG_t + \hat{\beta}_{i,4} BAAMSTY_t + \hat{\beta}_{i,5} PTFSBD_t + \hat{\beta}_{i,6} PTFSFX_t + \hat{\beta}_{i,7} PTFSCOM_t + \hat{\varepsilon}_{i,t}^{b} \quad (4)$$

Step 3: For each fund *i*, regress the returns of a given bootstrap sample, *b* on the 8-factor model. A positive or negative real estate market factor coefficient and *t*-statistic may result, since the bootstrap sample may have drawn an abnormally high number of positive/negative residuals.

Step 4: Repeat steps one to three for each of the individual funds and bootstrap iterations, and store the cross-sectional real estate market factor coefficients and corresponding *t*-statistics. We thus obtain a cross-sectional distribution of the real estate market factor's coefficients' *t*-statistic estimates which result purely from sampling variation as the null hypothesis of no fund level real estate exposure is imposed.

Step 5: Calculate the empirical *p*-values by comparing the distribution of *t*-statistics of the real estate market factor's coefficient from individual funds with that of coefficients from pseudo funds which have no real estate exposure (as measured through the real estate market factor).

Finding that the bootstrap distributions generate fewer extreme values for the real estate market factor coefficient (NAREIT, NCREIF NPI or TBI index based) than those observed in the actual data, would suggest that sampling variation is not the sole source of the empirical observation of fund level real estate exposure, but rather that the portfolios of hedge funds are genuinely comprised of real estate. Table 3 presents the results of the bootstrap analysis. Comparing the *p*-values for the test of the difference between the actual and pseudo funds reveals that the statistical significance of real estate exposure of actual funds cannot be attributed to sampling variation, hence providing a robust inference on the true real estate exposure of individual funds. Panels *A, B* and *C* display the results for the hedge funds that have

[12] Cao et al. (2013) use a similar method and "construct" mutual funds which don't have any liquidity timing skill by imposing the null hypothesis of zero timing skill on the liquidity factor's coefficient.

exposure to the NAREIT, NCREIF NPI and NCREIF TBI indexes, respectively. We rank funds according to the estimate of the real estate market factor's (*RE_MKT*) coefficient's *t*-statistic and report bootstrap results for the 1st, 5th, and 10th percentile on both sides of the *t*-statistic spectra. The results indicate that the estimated exposure of "top" real estate funds cannot be attributed to sampling variation. The bootstrapped *p*-values of the top (1st, 5th, and 10th) percentile funds is 0.00, implying that we can reject the null hypothesis that statistical significance of the real estate market factor's (*RE_MKT*) coefficient is driven by sampling variability at the 1% level of significance. Additionally, we see that bootstrapped *p*-values of the bottom (1st, 5th, and 10th) percentile funds are also equal to 0.00, again implying that we can reject the null hypothesis that statistical significance of the real estate market factor's (*RE_MKT*) coefficient is driven by sampling variability at the 1% level of significance. Thus, the bootstrap results are consistent with the individual fund level results and confirm the robustness of the real estate factors constructed from the NAREIT, NCREIF NPI and TBI indexes.

4.2 Efficacy of real estate factors

The previous sections augment the Fung-Hsieh factor model by introducing a real estate specific factor constructed from the NAREIT and NCREIF index, but does this really proxy for investments in the real estate market? To verify that our real estate market factor is truly "real estate" we regress the returns of various hedge fund indexes on the conventional 7-factor model and the complete 8-factor real estate model. Additionally, we examine the detailed strategy description provided in the hedge fund database and identify a sample of 45 non-debt and 91 debt related hedge funds. If the real estate factors constructed from the NAREIT, NCREIF NPI and TBI index truly represent a unique real estate source of variation, then the variation in returns of index portfolios of real estate debt and non-debt funds should be explained by the real estate factors.

Tables 4 through 6 report the results of regressions involving a range of hedge fund index excess returns from January 1994 to September 2008 for the NAREIT, NCREIF NPI and NCREIF TBI index

based factors respectively.[13] Table 4 presents results showing the incremental variation explained by the real estate factor through the conventional 7-factor model. The ratio of the Adjusted R-Squares of the 7-factor model to that of the 8-factor model with a real estate factor is close to 1 implying that the real estate market factor (*RE_MKT*) based on the NAREIT index does not explain a large portion of the variation in the returns of hedge funds that follow a range of diversified investment strategies. On the contrary, the index returns of real estate debt and non-debt related hedge funds have corresponding Adjusted R-Square ratios of 0.54 and 0.76 indicating that the real estate factor based on the NAREIT index does indeed have significant explanatory power.

Next, Table 5 presents results showing the incremental variation explained by the real estate factor based on the NCREIF NPI index. Here too the ratio of the Adjusted R-Squares of the 7-factor model to that of the 8-factor model with a real estate factor is close to 1 for most of the hedge fund index returns with the exception of the indexes that represent investment strategies of "Managed Futures" and "Multi Strategy" (lower Adjusted R-Square ratios of 0.85 and 0.77 respectively). However, the corresponding ratio for real estate debt funds is much lower at 0.55 indicating that the real estate factor based on the NCREIF NPI index has a significant real estate specific component. Finally, the regression output in Table 6 presents results on the incremental variation explained by the real estate factor based on the NCREIF TBI index. Here the Adjusted R-Square ratios of the 7-factor model to that of the 8-factor model are close to 1 for all the diversified hedge fund index returns as well as real estate fund index returns and hence implies that the NCREIF TBI based factor does not significantly explain the variation in returns of real estate hedge funds.

Taken together, the construction of the real estate market factors and its relation with various diversified hedge fund returns point to the existence of a real estate component to explain the returns of hedge funds that follow a real estate investment strategy. The overall conclusion is that the real estate

[13] A statistical breakpoint analysis identifies September 2008 as a significant time point that divides the sample into sub-periods. This is intuitive as it coincides with the period immediately before the highest decline in the NAREIT and NCREIF index. We focus on the time period before the financial crisis to avoid any correlation inherent in the index returns after the crisis.

market factors based on the NAREIT and NCREIF index correctly detects variation in the real estate market, and not just a general trend.

5. Do hedge fund strategies systematically use real estate investments?

Although hedge funds self-report investment strategy classifications to data vendors and most do not report a real estate investment strategy, our empirical analysis explicitly identifies funds that have exposure to the direct or indirect real estate market. Thus, using that empirical identification, we now focus on answering the question: Do certain hedge fund strategies systematically use real estate investments?

Before comparing hedge funds across exposure to the direct versus securitized real estate market or across varying levels of exposure to the real estate market, we control for other potential fund characteristics that may influence our final inference. First, we perform a matching procedure to identify hedge funds that have similar exposure across the conventional seven risk factors but different levels of exposure to the securitized or direct real estate market.

Following Cao, Simin, and Wang (2013) we perform the following matching procedure:

Step 1. For each hedge fund among the group of real estate loading funds, estimate the Fung-Hsieh factor model and preserve betas of each factor.

Step 2. Estimate the 7-factor model for non-real estate hedge funds and retain the betas corresponding to each risk factor.

Step 3. Compute the distance score statistic for each combination of funds *i* and *j* across groups in steps 1 and 2 as:

$$Score_{i,j} = \left(\frac{\beta_{MKT,i} - \beta_{MKT,j}}{0.5(\beta_{MKT,i} + \beta_{MKT,j})}\right)^2 + \left(\frac{\beta_{SMB,i} - \beta_{SMB,j}}{0.5(\beta_{SMB,i} + \beta_{SMB,j})}\right)^2 + \left(\frac{\beta_{YLDCHG,i} - \beta_{YLDCHG,j}}{0.5(\beta_{YLDCHG,i} + \beta_{YLDCHG,j})}\right)^2 + \left(\frac{\beta_{BAAMSTY,i} - \beta_{BAAMSTY,j}}{0.5(\beta_{BAAMSTY,i} + \beta_{BAAMSTY,j})}\right)^2$$

$$+ \left(\frac{\beta_{PTFSBD,i} - \beta_{PTFSBD,j}}{0.5(\beta_{PTFSBD,i} + \beta_{PTFSBD,j})}\right)^2 + \left(\frac{\beta_{PTFSFX,i} - \beta_{PTFSFX,j}}{0.5(\beta_{PTFSFX,i} + \beta_{PTFSFX,j})}\right)^2 + \left(\frac{\beta_{PTFSCOM,i} - \beta_{PTFSCOM,j}}{0.5(\beta_{PTFSCOM,i} + \beta_{PTFSCOM,j})}\right)^2 \quad (5)$$

Step 4. Select the funds that have the lowest score and classify them as matching funds.

The procedure matches the 1,235 real estate hedge funds with 1,235 non real estate hedge funds. Additionally, we contrast 402 NCREIF NPI loading with 402 NAREIT loading funds, and 329 NCREIF TBI loading with 329 NAREIT loading. The matching procedure ensures that hedge funds have similar risk characteristics based on the 7-factor model, but different real estate risk exposure. Hence, any inference thus drawn can be attributed to the level of real estate risk.

We first examine in Table 7 the proportion of funds within each general strategy classification that have significant real estate factor loadings. In 4 out of the 11 classification categories, real estate fund representation or weighting differs from the matched sample non-real estate funds. We find that a statistically higher (at the 5% level) proportion of non-real estate funds follow the "Long/Short Equity Hedge" and "Managed Futures" strategies. Also, a marginally higher proportion of real estate funds follow the "Convertible Arbitrage" and "Equity Market Neutral" strategy. As a result, it appears that the real estate loading funds are not primarily clustered among any specific strategy classification. For comparison, we also report in Table 7 the distribution of all hedge funds in the TASS database across the strategy classification categories. The real estate fund distribution across categories differs from the overall population in 7 out of the 11 classification strategies suggesting that the real estate funds are indeed different from the general population trends.

In Table 8, we compare the strategy classifications based on the individual real estate index loadings to determine if there are systematic differences in fund categories with respect to direct versus indirect real estate exposure for those funds that are classified as real estate funds. Panel A reports the strategy classification of hedge funds that load on the NCREIF NPI based factor versus the NAREIT based factor. We find that 57.5% of hedge funds that are classified as having exposure to direct real estate (NCREIF) have an investment strategy classification of "Fund of funds". This marginally increases to 59.0% for funds that load on the NAREIT based factor; however this difference in proportion is not statistically significant. Furthermore, we see that 14.9% of the "Long/Short Equity Hedge" funds with

significant real estate exposure load on the direct real estate factor while 20.9% load on the NAREIT factor. In contrast, we see that funds with significant real estate exposure that are classified as "Fixed Income Arbitrage", "Global Macro" and "Managed Futures" have significantly higher exposure to direct real estate (NCREIF NPI), whereas funds that are classified as "Long/Short Equity" have significantly higher exposure to indirect real estate (NAREIT) versus direct real estate investment

Table 8, Panel B reports a comparison for the NCREIF TBI loading and NAREIT loading hedge funds. For example, we see that 55.6% of hedge funds that are classified as having exposure to the NCREIF TBI based factor have an investment strategy classification of "Fund of Hedge funds", which is statistically different from the 47.7% of funds that load on the NAREIT based factor. Also, we find that the 13.7% of direct real estate based funds in the investment strategy of "Long/Short Equity Hedge" is lower (significant at the 1% level) than the 24.3 % of "Long/Short Equity Hedge" funds loading on the NAREIT factor. A marginally higher proportion of real estate funds that load on NCREIF TBI (3.34%) follow the "Convertible Arbitrage" compared to NAREIT (0.30%). Also, we do see a significant (at the 5% level) difference in the proportion of funds in the "Multi-Strategy" category that load on NCREIF TBI (4.86%) versus NAREIT (9.12%). Overall, the results in Table 8 suggests that changing the measure of direct real estate from the NCREIF NPI to the TBI based factor changes the conclusion that the majority of hedge funds that have significant exposure to direct real estate are fund of funds.

6. Real Estate Investment and Fund characteristics

Next, we examine the differences in fund characteristics based on whether the fund has exposure to direct or indirect real estate as well as the differences in characteristics for real estate and non-real estate hedge funds. Table 9 compares real estate and non-real estate hedge funds based on self-reported use of leverage, investment in other funds, utilization of futures, derivatives, margin borrowing, or foreign exchange credit, and whether managers have "Personal Capital" at stake in the fund. We also report the characteristics of the population of hedge funds for comparison. Similar to the hedge fund population, we

find that non-real estate funds are equally leveraged (50% versus 51%) and not statistically different. We see that non-real estate funds are more likely to use futures contracts (17% versus 12%) than real estate funds and both groups are less likely to use futures contracts than the overall population of hedge funds. Additionally, we find a higher occurrence of principals investing personal capital in non-real estate funds (26%) versus real estate funds (19%). Interestingly, the percentage of principals investing personal capital is greater in both sets than the overall population.

Table 10 reports similar comparisons between real estate funds that have exposure to direct (NCREIF) or indirect (NAREIT) real estate. Panel A contrasts hedge funds that load on the NCREIF NPI and NAREIT factors and the test-statistics for the differences in proportions are not significant. Panel B contrasts across the alternative measure for direct real estate, the NCREIF TBI with the NAREIT based factor. We see that 6% of funds that are classified as having exposure to the direct real estate market (NCREIF TBI) report usage of FX Credit compared to 11% that have exposure to the securitized market (statistically significant at the 10% level). Consistent with the strategy classification of "Fund of Funds" discussed in the previous section, we find that a high percentage of funds report investment in other funds (55.6% and 47.1% for NCREIF TBI and NAREIT loading funds respectively). Also, we find a higher occurrence of principals investing personal capital in NAREIT loading funds (26%) versus direct real estate funds (17%).

In addition to examining differences in fund characteristics, we also contrast investment criteria across varying real estate exposure. In other words, we test whether real estate investment is systematically related to individual fund investment criteria such as minimum investment amounts, lock-up and redemption notice periods, as well as fund governance structures involving management fees and leverage. Table 11 presents the results for the logistic regression where the dependent variable equals one for real estate funds and zero for non-real estate funds. We see that real estate funds have significantly lower (at the 1% level) incentive fees than real estate funds. Furthermore, real estate funds have significantly (at the 1% level) higher high water marks and lower leverage than non-real estate funds. However, we find no significant difference in minimum investments, management fee, and redemption or

lock-up periods. In columns (2) and (3), we examine differences in direct (NCREIF) and indirect (NAREIT) loading factors. The statistically significant coefficients for redemption notice period indicate that, compared to hedge funds that have exposure to the securitized real estate market, funds that have exposure to direct real estate have less account liquidity (longer redemption periods). Also, hedge funds that have exposure to the direct real estate market have lower minimum investment requirements, lower high water marks and higher leverage.

7. Economic Value of Real Estate Exposure

In the previous sections, we identified hedge funds that have exposure to direct or indirect real estate. Thus, in this section we turn to the question of what is the economic impact of investing across these two groups of hedge funds. To understand the economic impact, we contrast the performance of "tracking" portfolios of real estate hedge funds against portfolios of funds that do not load on the real estate market factors (NAREIT, NCREIF NPI or TBI loading).

In each quarter from December 1999, we estimate the real estate market factor's coefficient for each fund using the past 24-quarter estimation period, and form two portfolios based on the statistical significance of the real estate market factor's coefficient (5% level of significance). Hence, we have rolling portfolios across two groups: one portfolio index representing hedge funds' returns that are explained by the real estate market factor; and the second portfolio index comprising funds that do not load on the real estate market factor.[14] Portfolios are re-balanced every quarter based on the level of real estate exposure measured through the estimated coefficient of the real estate market factor ($NAREIT\_MKT_t, NPI\_MKT_t, TBI\_MKT_t$).

Figure 6 presents a striking contrast of the economic impact of funds that "track" the direct real estate market (NCREIF NPI) versus those that track the securitized market (NAREIT). Hedge funds that

[14] Since portfolios are adjusted to reflect funds that load and do not load on the real estate market factor, the two portfolios thus created represent hedge funds with varying levels of exposure to the real estate market.

have exposure to direct real estate provide a return of 5.07%, whereas funds that have exposure to the securitized market provide a return of 5.97%. Up to September 2008, funds with exposure to direct real estate provided a return of 5.81%, whereas funds that had exposure to securitized real estate provided a return of 6.77%. Using NCREIF TBI as an alternative measure, we see that hedge funds that have exposure to direct real estate generated returns of 5.80%.

Figure 7 contrasts the economic impact of funds that "track" the real estate market (NAREIT, NCREIF NPI or TBI) against those that do not. Hedge funds that have exposure to the real estate market provide a return of 5.13%, whereas funds that do not have exposure to the real estate market generated a return of 5.06%. Up to September 2008, funds with exposure to real estate earned a return of 6.05%, whereas funds that did not have exposure to real estate provided a return of 5.72%. Overall, we infer that the returns of hedge funds differ with investment strategies that vary through the level of real estate exposure.

8. Out of sample tests

In this section, we examine the question of whether real estate exposure increases the returns to fund investors. To gauge the significance of our direct and indirect real estate measures, we investigate the investment value of selecting portfolios based on varying levels of real estate exposure. In each quarter starting from December 1999, we estimate the real estate factor's coefficient (NAREIT, NCREIF NPI or TBI based residual factors) for each fund using the past 24-quarter estimation window, and then form portfolios based on the statistical significance of the real estate factor coefficients. This yields distinct time series of returns based on varying levels of real estate exposure from 1999 to 2012. If a fund disappears over the holding period, its returns are included in calculating the portfolio returns until its disappearance, and the portfolio is rebalanced going forward. Next we estimate the seven-factor model and report each portfolio's "out-of-sample" alpha.

Table 12 presents evidence of the economic value of real estate exposure. Specifically, the spread from NAREIT and NCREIF loading based portfolios indicates that the alphas generated by funds that load on direct real estate are not statistically different from the alphas generated by funds loading on indirect real estate. However, the results show that funds with real estate exposure do generate significant alphas. Thus, we conclude that hedge fund exposure to direct or indirect real estate does not provide a differential economic outcome.

Finally, we contrast the investment performance of real estate versus non-real estate hedge funds across in Table 13. First we note that both real estate and non-real estate funds generated positive alphas over the sample period. However, comparing the performance differential between them, we see that real estate hedge funds do not generate statistically greater alpha than real estate loading funds.

In summary, we find strong evidence that real estate exposure does not add significantly different value to fund investors. As a result, real estate investment does not appear to be a source of hedge fund alpha and the level of real estate exposure does not reflect hedge fund managerial skill.

9. Conclusion

In this paper, we explore a new dimension of hedge funds' investment strategy relating to their exposure to the real estate market. Our analysis reveals that 1,238 out of 3,669 hedge funds had significant exposure to the real estate market even though they were not classified as "real estate funds". To evaluate the performance of these funds we construct real estate market factors that proxy for the return in the direct and indirect/securitized real estate market. Through a bootstrap analysis we provide robust evidence that the observed real estate exposure at the individual fund level cannot be attributed to sampling variation. Additionally, we confirm the efficacy of the real estate factors through the lack of variation explained in diversified hedge fund index returns.

We investigate the characteristics of funds that vary with levels of real estate exposure. Most importantly, we control for risk characteristics to ensure comparison across funds that vary only through

varying levels of real estate exposure through a normed distance based matching algorithm. Our matching procedure ensures that any inference thus drawn can be attributed to the level of real estate risk. We document that funds with significant real estate exposure have lower incentive fees, similar account liquidity, lower leverage, and higher high water mark levels. Compared to hedge funds that have exposure to securitized real estate, funds that have exposure to the direct real estate market have higher leverage, longer redemption periods (less account liquidity), lower high water marks, and lower minimum investment requirements. We test for the economic impact across funds with varying levels of real estate exposure, and show that funds with significant real estate exposure do not significantly outperform funds that do not have real estate exposure. Contrasting hedge funds based on exposure to the direct or securitized real estate market, we show that exposure to investment strategies based on either source of real estate risk does not provide a differential economic outcome.

While the analysis of hedge fund performance and asset class styles is not new, this is the first study to document the extent to which hedge funds have exposure to real estate based investments. Since real estate is a major asset class, our results suggest that proper implementation of asset allocation models should account for whether hedge funds actually provide investors with exposure to real estate. Furthermore, we find an interesting puzzle in that hedge funds that have significant exposure to the real estate market factors do not outperform funds that do not load on the real estate factors. Given that real estate significantly outperformed the stock market during the previous decade, the finding that funds with real estate exposure do not outperform is a puzzle.

Appendix

Hedge Fund Investment Strategy Descriptions:

- Convertible Arbitrage: funds that aim to profit from the purchase of convertible securities and subsequent shorting of the corresponding stock.
- Dedicated Short Bias: funds that take more short positions than long positions and earn returns by maintaining net short exposure in long and short equities.
- Emerging Markets: measures funds that invest in currencies, debt instruments, equities and other instruments of countries with “emerging” or developing markets.
- Equity Market Neutral: funds take long and short positions in stocks while reducing exposure to the systematic risk of the market.
- Event Driven funds (Distressed, Multi-Strategy and Risk Arbitrage subsectors): invest in various asset classes and seek to profit from potential mispricing of securities related to a specific corporate or market event.
- Fixed Income Arbitrage: funds that exploit inefficiencies and price anomalies between related fixed income securities.
- Global Macro: funds that focus on identifying extreme price valuations and often use leverage in anticipating price movements in equity, currency, interest-rate and commodity markets.
- Long/Short Equity: funds that invest in both long and short sides of equity markets.
- Managed Futures: funds focus on investing in listed bond, equity, commodity futures and currency markets, globally.
- Multi-Strategy: funds that are characterized by their ability to allocate capital based on perceived opportunities among several hedge fund strategies.
- Hedge Fund Index: an all-encompassing investment strategy across all the asset classes and styles.

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Table 1: Summary statistics of factor data.

This table reports quarterly summary statistics of the *CRSP* value weighted market return, the NAREIT index return, the NCREIF (NPI) index return, the NCREIF (TBI) index return, as well as the Fung-Hsieh seven factors including the market excess return (*MKT*), a size factor (*SMB*), change in the 10-year treasury constant maturity yield (*YLDCHG*), change in the Moody's Baa yield less 10-year treasury constant maturity yield (*BAAMTSY*), and three trend-following factors: *PTFSBD* (bond), *PTFSFX* (currency), *PTFSCOM* (commodity). The sample period is from January 1994 to December 2012.

	Mean	Median	STD	25%	75%
Panel A: Market indexes					
CRSP	0.0241	0.0327	0.0914	-0.0201	0.0798
NAREIT	0.0299	0.0275	0.1009	-0.0109	0.0883
NCREIF (NPI)	0.0227	0.0262	0.0237	0.0184	0.0349
NCREIF (TBI)	0.0270	0.0198	0.0560	-0.0002	0.0543
Panel B: Fung-Hsieh factors					
MKT	0.0168	0.0257	0.0913	-0.0287	0.0717
SMB	0.0053	0.0049	0.0459	-0.0199	0.0270
YLDCHG	-0.0005	-0.0001	0.0049	-0.0043	0.0036
BAAMSTY	0.0001	-0.0003	0.0046	-0.0022	0.0018
PTFSBD	-0.0322	-0.1297	0.3317	-0.2565	0.0946
PTFSFX	-0.0146	-0.1231	0.3486	-0.2535	0.1985
PTFSCOM	-0.0207	-0.0782	0.2187	-0.1726	0.1060

Table 2: Summary statistics of average returns on real estate oriented hedge funds.

This table presents summary statistics of average quarterly returns of real estate and non-real estate hedge funds. N is the number of funds that exist any time during the sample period. The sample period is from January 1994 to December 2012. NAREIT loading funds are hedge funds that have a statistically significant coefficient on the real estate market factor (RE_MKT) constructed from the NAREIT index. NCREIF NPI loading funds are hedge funds that have a statistically significant coefficient on the real estate market factor (RE_MKT) constructed from the NCREIF NPI index. NCREIF TBI loading funds are hedge funds that have a statistically significant coefficient on the real estate market factor (RE_MKT) constructed from the NCREIF TBI index. Real estate funds are hedge funds that have a statistically significant coefficient on the real estate market factor (RE_MKT) constructed from the NAREIT, NCREIF NPI or TBI index. Non real estate funds are hedge funds that do not have a statistically significant coefficient on the real estate market factor (RE_MKT) constructed from the NAREIT, NCREIF NPI or TBI index.

	N	Mean	Median	STD	25%	75%
Panel A: All hedge funds						
All funds	3,669	0.0177	0.0184	0.0663	-0.0074	0.0426
Non real estate funds	2,431	0.0191	0.0195	0.0677	-0.0074	0.0444
Real estate funds	1,238	0.0145	0.0162	0.0628	-0.0074	0.0389
Panel B: Real estate hedge funds						
NAREIT loading funds	458	0.0150	0.0178	0.0639	-0.0107	0.0425
NCREIF (NPI) loading funds	705	0.0141	0.0156	0.0620	-0.0056	0.0369
NCREIF (TBI) loading funds	368	0.0126	0.0151	0.0635	-0.0079	0.0368

Table 3: Statistical significance of individual fund level real estate exposure based on the bootstrapped method.

Panel *A* presents the statistical significance of real estate exposure for *NAREIT* loading funds. Panels *B* and *C* present results for *NCREIF NPI* and *TBI* loading funds. The real estate market factor's coefficient is estimated relative to the Fung-Hsieh factors. NAREIT, NCREIF NPI and NCREIF TBI loading funds are hedge funds that have a statistically significant coefficient on the real estate market factor (RE_MKT) constructed from the NAREIT, NCREIF NPI or NCREIF TBI indexes respectively. The first and second rows report the *t*-statistic of the real estate market factor's coefficient based on heteroscedasticity and autocorrelation consistent standard errors and the bootstrapped *p*-value of the *t*-statistic. Values are reported for the top and bottom 1%, 5%, and 10% funds. The sample period is from January 1994 to December 2012.

	Bottom			Top		
	1%	5%	10%	10%	5%	1%
NAREIT loading funds						
t-statistic	-6.70	-5.66	-4.97	3.18	3.99	5.86
p-value	0.00	0.00	0.00	0.00	0.00	0.00
NCREIF NPI loading funds						
t-statistic	-7.25	-6.03	-4.76	5.43	6.11	8.14
p-value	0.00	0.00	0.00	0.00	0.00	0.00
NCREIF TBI loading funds						
t-statistic	-5.72	-4.30	-3.69	5.11	5.71	7.31
p-value	0.00	0.00	0.00	0.00	0.00	0.00

Table 4: Why focus on the *NAREIT* based factor? Variation in hedge fund index portfolios explained by the real estate market factor.

This table reports the Adjusted R^2 and ratio of Adjusted R^2 of a single factor model for 16 hedge fund index portfolios to the Adjusted R^2 of the full 8-factor model. Time series regressions of the single factor model, 7-factor and 8-factor models are as follows:

$$r_{i,t} = \alpha_i + \beta_{i,1} MKT_t + \varepsilon_{i,t}$$

$$r_{i,t} = \alpha_i + \beta_{i,1} MKT_t + \beta_{i,3} SMB_t + \beta_{i,4} YLDCHG_t + \beta_{i,5} BAAMSTY_t + \beta_{i,6} PTFSBD_t + \beta_{i,7} PTFSFX_t + \beta_{i,8} PTFSCOM_t + \varepsilon_{i,t}$$

$$r_{i,t} = \alpha_i + \beta_{i,1} MKT_t + \beta_{i,2} RE\_MKT_t + \beta_{i,3} SMB_t + \beta_{i,4} YLDCHG_t + \beta_{i,5} BAAMSTY_t + \beta_{i,6} PTFSBD_t + \beta_{i,7} PTFSFX_t + \beta_{i,8} PTFSCOM_t + \varepsilon_{i,t}$$

The dependent variable $r_{i,t}$ is the monthly excess return for an index portfolio of hedge funds. Explanatory variables are the market excess return (*MKT*), the real estate market factor (*RE_MKT*) based on the *NAREIT* index, a size factor (*SMB*), change in the 10-year treasury constant maturity yield (*YLDCHG*), change in the Moody's Baa yield less 10-year treasury constant maturity yield (*BAAMTSY*), three trend-following factors: *PTFSBD* (bond), *PTFSFX* (currency), *PTFSCOM* (commodity). The index return regressions are estimated for the time period from January 1994 to September 2008, comprising of 59 quarterly observations.

Portfolio	Adjusted R^2 *MKT* factor model	Adjusted R^2 7-factor model	Adjusted R^2 8-factor model	Ratio of Adjusted R^2 (1-factor *MKT*/7-factor model)	Ratio of Adjusted R^2 (7-factor /8-factor *NAREIT* model)
Real estate non-debt	0.19	0.29	0.54	0.65	0.54
Real estate debt	0.02	0.11	0.14	0.16	0.76
Hedge Fund Index	0.42	0.47	0.46	0.88	1.02
Convertible Arbitrage	0.08	0.15	0.14	0.54	1.08
Dedicated Short Bias	0.65	0.65	0.67	1.01	0.96
Emerging Markets	0.27	0.27	0.28	1.00	0.98
Equity Market Neutral	0.09	0.05	0.03	1.75	1.48
Event Driven Hedge	0.45	0.54	0.54	0.84	0.99
Event Driven Distressed	0.43	0.50	0.51	0.86	0.98
Event Driven Multi-Strategy	0.40	0.49	0.49	0.81	1.00
Event Driven Risk Arbitrage	0.34	0.35	0.38	0.98	0.91
Fixed Income Arbitrage	0.05	0.36	0.35	0.14	1.03
Global Macro	0.04	0.11	0.10	0.38	1.18
Long Short Equity	0.60	0.58	0.60	1.04	0.95
Managed Futures	0.08	0.23	0.22	0.36	1.05
Multi Strategy	0.08	0.21	0.21	0.40	0.99

Table 5: Why focus on the *NCREIF NPI* based factor? Variation in hedge fund index portfolios explained by the real estate market factor.

This table reports the Adjusted R^2 and ratio of Adjusted R^2 of a single factor model for 16 hedge fund index portfolios to the Adjusted R^2 of the full 8-factor model. Time series regressions of the single factor model, 7-factor and 8-factor models are as follows:

$$r_{i,t} = \alpha_i + \beta_{i,1} MKT_t + \varepsilon_{i,t}$$

$$r_{i,t} = \alpha_i + \beta_{i,1} MKT_t + \beta_{i,3} SMB_t + \beta_{i,4} YLDCHG_t + \beta_{i,5} BAAMSTY_t + \beta_{i,6} PTFSBD_t + \beta_{i,7} PTFSFX_t + \beta_{i,8} PTFSCOM_t + \varepsilon_{i,t}$$

$$r_{i,t} = \alpha_i + \beta_{i,1} MKT_t + \beta_{i,2} RE\_MKT_t + \beta_{i,3} SMB_t + \beta_{i,4} YLDCHG_t + \beta_{i,5} BAAMSTY_t + \beta_{i,6} PTFSBD_t + \beta_{i,7} PTFSFX_t + \beta_{i,8} PTFSCOM_t + \varepsilon_{i,t}$$

The dependent variable $r_{i,t}$ is the monthly excess return for an index portfolio of hedge funds. Explanatory variables are the market excess return (*MKT*), the real estate market factor (*RE_MKT*) based on the *NCREIF NPI* index, a size factor (*SMB*), change in the 10-year treasury constant maturity yield (*YLDCHG*), change in the Moody's Baa yield less 10-year treasury constant maturity yield (*BAAMTSY*), three trend-following factors: *PTFSBD* (bond), *PTFSFX* (currency), *PTFSCOM* (commodity). The index return regressions are estimated for the time period from January 1994 to September 2008, comprising of 59 quarterly observations.

Portfolio	Adjusted R^2 *MKT* factor model	Adjusted R^2 7-factor model	Adjusted R^2 8-factor model	Ratio of Adjusted R^2 (1-factor *MKT*/7-factor model)	Ratio of Adjusted R^2 (7-factor /8-factor *NCREIF NPI* model)
Real estate non-debt	0.19	0.29	0.32	0.65	0.91
Real estate debt	0.02	0.11	0.20	0.16	0.55
Hedge Fund Index	0.42	0.47	0.46	0.88	1.02
Convertible Arbitrage	0.08	0.15	0.14	0.54	1.09
Dedicated Short Bias	0.65	0.65	0.66	1.01	0.99
Emerging Markets	0.27	0.27	0.26	1.00	1.04
Equity Market Neutral	0.09	0.05	0.03	1.75	1.56
Event Driven Hedge	0.45	0.54	0.53	0.84	1.02
Event Driven Distressed	0.43	0.50	0.49	0.86	1.02
Event Driven Multi-Strategy	0.40	0.49	0.48	0.81	1.02
Event Driven Risk Arbitrage	0.34	0.35	0.34	0.98	1.03
Fixed Income Arbitrage	0.05	0.36	0.37	0.14	0.99
Global Macro	0.04	0.11	0.10	0.38	1.15
Long Short Equity	0.60	0.58	0.57	1.04	1.00
Managed Futures	0.08	0.23	0.27	0.36	0.85
Multi Strategy	0.08	0.21	0.27	0.40	0.77

Table 6: Why focus on the *NCREIF TBI* based factor? Variation in hedge fund index portfolios explained by the real estate market factor.

This table reports the Adjusted R^2 and ratio of Adjusted R^2 of a single factor model for 16 hedge fund index portfolios to the Adjusted R^2 of the full 8-factor model. Time series regressions of the single factor model, 7-factor and 8-factor models are as follows:

$$r_{i,t} = \alpha_i + \beta_{i,1} MKT_t + \varepsilon_{i,t}$$

$$r_{i,t} = \alpha_i + \beta_{i,1} MKT_t + \beta_{i,3} SMB_t + \beta_{i,4} YLDCHG_t + \beta_{i,5} BAAMSTY_t + \beta_{i,6} PTFSBD_t + \beta_{i,7} PTFSFX_t + \beta_{i,8} PTFSCOM_t + \varepsilon_{i,t}$$

$$r_{i,t} = \alpha_i + \beta_{i,1} MKT_t + \beta_{i,2} RE\_MKT_t + \beta_{i,3} SMB_t + \beta_{i,4} YLDCHG_t + \beta_{i,5} BAAMSTY_t + \beta_{i,6} PTFSBD_t + \beta_{i,7} PTFSFX_t + \beta_{i,8} PTFSCOM_t + \varepsilon_{i,t}$$

The dependent variable $r_{i,t}$ is the monthly excess return for an index portfolio of hedge funds. Explanatory variables are the market excess return (*MKT*), the real estate market factor (*RE_MKT*) based on the *NCREIF TBI* index, a size factor (*SMB*), change in the 10-year treasury constant maturity yield (*YLDCHG*), change in the Moody's Baa yield less 10-year treasury constant maturity yield (*BAAMTSY*), three trend-following factors: *PTFSBD* (bond), *PTFSFX* (currency), *PTFSCOM* (commodity). The index return regressions are estimated for the time period from January 1994 to September 2008, comprising of 59 quarterly observations.

Portfolio	Adjusted R^2 *MKT* factor model	Adjusted R^2 7-factor model	Adjusted R^2 8-factor model	Ratio of Adjusted R^2 (1-factor *MKT*/7-factor model)	Ratio of Adjusted R^2 (7-factor /8-factor *NCREIF TBI* model)
Real estate non-debt	0.19	0.29	0.28	0.65	1.05
Real estate debt	0.02	0.11	0.09	0.16	1.19
Hedge Fund Index	0.42	0.47	0.46	0.88	1.02
Convertible Arbitrage	0.08	0.15	0.14	0.54	1.06
Dedicated Short Bias	0.65	0.65	0.65	1.01	1.00
Emerging Markets	0.27	0.27	0.27	1.00	0.99
Equity Market Neutral	0.09	0.05	0.03	1.75	1.51
Event Driven Hedge	0.45	0.54	0.54	0.84	1.00
Event Driven Distressed	0.43	0.50	0.50	0.86	1.00
Event Driven Multi-Strategy	0.40	0.49	0.49	0.81	1.00
Event Driven Risk Arbitrage	0.34	0.35	0.34	0.98	1.04
Fixed Income Arbitrage	0.05	0.36	0.36	0.14	1.01
Global Macro	0.04	0.11	0.09	0.38	1.18
Long Short Equity	0.60	0.58	0.57	1.04	1.01
Managed Futures	0.08	0.23	0.22	0.36	1.06
Multi Strategy	0.08	0.21	0.22	0.40	0.94

Table 7: Strategy classification of real estate vs. non-real estate hedge funds

This table presents the strategy classification of hedge funds as reported to the data vendor. Funds that load on the NAREIT, NCREIF NPI or TBI residual factors are classified as real estate funds. Non real estate funds do not load on any of the three real estate measures. The values in the second, third, and fourth columns are percentage of funds that correspond to the investment strategy in the first column. N is the number of funds. The last 3 columns indicate the *p*-value of the Z-test for equality of proportions for columns indicated.

	All funds (%)	Real estate funds (%)	Matched Non-real estate funds (%)	Difference (*p*-value) Cols. 2 vs. 3	Difference (*p*-value) Cols. 2 vs. 4	Difference (*p*-value) Cols 3 vs. 4
Convertible Arbitrage	1.63	3.08	1.94	(0.00)	(0.45)	(0.07)
Dedicated Short Bias	0.29	0.32	0.00	(0.85)	(0.08)	(0.13)
Emerging Markets	4.98	3.48	2.51	(0.01)	(0.00)	(0.19)
Equity Market Neutral	3.98	3.32	2.02	(0.22)	(0.00)	(0.05)
Event Driven	4.65	6.23	6.40	(0.03)	(0.02)	(0.87)
Fixed Income Arbitrage	2.46	2.27	2.19	(0.66)	(0.53)	(0.89)
Fund of Funds	37.54	49.64	47.77	(0.00)	(0.00)	(0.36)
Global Macro	4.35	2.35	2.67	(0.00)	(0.00)	(0.61)
Long/Short Equity Hedge	21.13	19.27	23.32	(0.11)	(0.08)	(0.01)
Managed Futures	5.84	2.43	3.81	(0.00)	(0.00)	(0.05)
Multi-Strategy	13.16	7.61	7.37	(0.00)	(0.00)	(0.82)
N	14,007	1,235	1,235			

Table 8: Strategy classification of real estate hedge funds

This table presents the strategy classification of hedge funds as reported to the data vendor. Panel *A* contrasts funds that load on the NCREIF (NPI) residual or NAREIT residual factors. Panel *B* contrasts funds that load on the NCREIF (TBI) residual or NAREIT residual factors. The values in the second, third and fourth columns are percentage of funds that correspond to the investment strategy in the first column. N is the number of funds. The last 3 columns indicate the *p*-value of the Z-test for equality of proportions for columns indicated.

Panel A: NCREIF NPI and NAREIT loading funds

	All funds (%)	*NCREIF* loading (*NPI*) (%)	*NAREIT* loading (%)	Difference (*p*-value) Cols. 2 vs. 3	Difference (*p*-value) Cols. 2 vs. 4	Difference (*p*-value) Cols. 3 vs. 4
Convertible Arbitrage	1.63	0.25	0.50	(0.02)	(0.10)	(1.00)
Dedicated Short Bias	0.29	0.00	0.75	(0.63)	(0.12)	(0.25)
Emerging Markets	4.98	3.73	2.99	(0.20)	(0.02)	(0.56)
Equity Market Neutral	3.98	2.24	2.74	(0.02)	(0.14)	(0.65)
Event Driven	4.65	6.47	4.98	(0.14)	(0.77)	(0.36)
Fixed Income Arbitrage	2.46	2.24	0.00	(0.77)	(0.00)	(0.00)
Fund of Funds	37.54	57.46	58.96	(0.00)	(0.00)	(0.67)
Global Macro	4.35	2.24	0.25	(0.01)	(0.00)	(0.02)
Long/Short Equity Hedge	21.13	14.93	20.90	(0.00)	(0.91)	(0.03)
Managed Futures	5.84	2.99	0.50	(0.00)	(0.00)	(0.01)
Multi-Strategy	13.16	7.46	7.46	(0.00)	(0.00)	(1.00)
N	14,007	402	402			

Panel B: NCREIF TBI and NAREIT loading funds

	All funds (%)	*NCREIF* loading (*TBI*) (%)	*NAREIT* loading (%)	Difference (*p*-value) Cols. 2 vs. 3	Difference (*p*-value) Cols. 2 vs. 4	Difference (*p*-value) Cols. 3 vs. 4
Convertible Arbitrage	1.63	3.34	0.30	(0.09)	(0.07)	(0.00)
Dedicated Short Bias	0.29	0.30	0.30	(0.62)	(0.62)	(1.00)
Emerging Markets	4.98	3.95	3.65	(0.52)	(0.21)	(1.00)
Equity Market Neutral	3.98	3.34	4.26	(0.53)	(0.80)	(0.54)
Event Driven	4.65	10.03	7.90	(0.00)	(0.03)	(0.34)
Fixed Income Arbitrage	2.46	1.22	0.00	(0.20)	(0.00)	(0.12)
Fund of Funds	37.54	55.62	47.72	(0.00)	(0.00)	(0.04)
Global Macro	4.35	2.13	0.61	(0.00)	(0.00)	(0.18)
Long/Short Equity Hedge	21.13	13.68	24.32	(0.00)	(0.18)	(0.00)
Managed Futures	5.84	1.52	1.82	(0.00)	(0.00)	(1.00)
Multi-Strategy	13.16	4.86	9.12	(0.00)	(0.01)	(0.03)
N	14,007	329	329			

Table 9: Characteristics of real estate vs. non real estate funds

This table presents the characteristics of hedge funds as reported to the data vendor. Funds that load on the NAREIT, NCREIF NPI or TBI residual factors are classified as real estate funds. Non real estate funds do not load on any of the three real estate measures. The values in the second, third and fourth columns are percentage of funds that correspond to the characteristic in the first column. The value in parenthesis is the number of funds. The last 3 columns indicate the *p*-value of the Z-test for equality of proportions for columns indicated.

	All funds (%)	Real estate funds (%)	Non-real estate funds (%)	Difference (*p*-value) Cols. 2 vs. 3	Difference (*p*-value) Cols. 2 vs. 4	Difference (*p*-value) Cols. 3 vs. 4
Leveraged	51.88 (14007)	51.09 (1235)	49.72 (1235)	(0.60)	(0.14)	(0.50)
Invests in Other funds	37.15 (14007)	48.83 (1235)	46.88 (1235)	(0.00)	(0.00)	(0.33)
Futures	19.20 (8209)	11.92 (847)	16.87 (818)	(0.00)	(0.11)	(0.00)
Derivatives	20.01 (8209)	15.35 (847)	14.91 (818)	(0.00)	(0.00)	(0.81)
Margin	32.16 (8209)	32.23 (847)	32.27 (818)	(0.97)	(0.95)	(0.99)
FX Credit	8.19 (8209)	8.03 (847)	9.66 (818)	(0.87)	(0.15)	(0.24)
Personal Capital	17.26 (14007)	19.43 (1235)	25.67 (1235)	(0.05)	(0.00)	(0.00)

Table 10: Characteristics of real estate hedge funds

This table presents the characteristics of hedge funds as reported to the data vendor. Panel *A* contrasts funds that load on the NCREIF (NPI) residual or NAREIT residual factors. Panel *B* contrasts funds that load on the NCREIF (TBI) residual or NAREIT residual factors. The values in the second, third and fourth columns are percentage of funds that correspond to the characteristic in the first column. The value in parenthesis is the number of funds. The last 3 columns indicate the *p*-value of the Z-test for equality of proportions for columns indicated.

Panel A: NCREIF NPI and NAREIT loading funds

	All funds (%)	*NCREIF* loading (*NPI*)	*NAREIT* loading	Difference (*p*-value) Cols. 2 vs. 3	Difference (*p*-value) Cols. 2 vs. 4	Difference (*p*-value) Cols. 3 vs. 4
Leveraged	51.88	48.51	46.27	(0.18)	(0.03)	(0.53)
	(14007)	(402)	(402)			
Invests in Other funds	37.15	56.97	58.46	(0.00)	(0.00)	(0.67)
	(14007)	(402)	(402)			
Futures	19.20	9.78	8.84	(0.00)	(0.00)	(0.71)
	(8209)	(276)	(249)			
Derivatives	20.01	17.75	14.46	(0.36)	(0.03)	(0.31)
	(8209)	(276)	(249)			
Margin	32.16	35.87	30.52	(0.20)	(0.59)	(0.19)
	(8209)	(276)	(249)			
FX Credit	8.19	6.88	8.43	(0.44)	(0.89)	(0.50)
	(8209)	(276)	(249)			
Personal Capital	17.26	22.14	18.66	(0.01)	(0.46)	(0.22)
	(14007)	(402)	(402)			

Panel B: NCREIF TBI and NAREIT loading funds

	All funds (%)	*NCREIF* loading (*TBI*)	*NAREIT* loading	Difference (*p*-value) Cols. 2 vs. 3	Difference (*p*-value) Cols. 2 vs. 4	Difference (*p*-value) Cols. 3 vs. 4
Leveraged	51.88	48.63	48.33	(0.24)	(0.20)	(0.94)
	(14007)	(329)	(329)			
Invests in Other funds	37.15	55.62	47.11	(0.00)	(0.00)	(0.03)
	(14007)	(329)	(329)			
Futures	19.20	9.30	7.96	(0.00)	(0.00)	(0.62)
	(8209)	(215)	(226)			
Derivatives	20.01	12.56	12.39	(0.01)	(0.01)	(0.96)
	(8209)	(215)	(226)			
Margin	32.16	29.30	30.97	(0.38)	(0.71)	(0.70)
	(8209)	(215)	(226)			
FX Credit	8.19	6.05	11.06	(0.26)	(0.00)	(0.06)
	(8209)	(215)	(226)			
Personal Capital	17.26	17.33	26.14	(0.97)	(0.00)	(0.00)
	(14007)	(329)	(329)			

Table 11. Logistic regressions on fund characteristics

Binary Logistic regressions are estimated on the cross-section of measures of estimated real estate exposure. The second column models the probability of being a NCREIF (NPI) loading fund. The third column models the probability of being a NCREIF (TBI) loading fund and the fourth column models the probability of being a real estate (NAREIT, NCREIF NPI or TBI) loading fund. The explanatory variables are hedge fund characteristics, such as the logarithm of minimum investment, management fee, incentive fee, high water mark, average leverage, lockup period, and redemption notice period. The time period is from January 1994 to December 2012. Standard-errors of the estimated coefficients are reported in parenthesis. *, **, *** indicate significance at the 10%, 5%, and 1% level.

	Binary Dependent variable		
	NAREIT vs. *NCREIF (NPI)* loading indicator	*NAREIT* vs. *NCREIF (TBI)* loading indicator	Real estate vs. non-real estate loading indicator
Intercept	0.7409	2.2471***	0.0960
	(0.6057)	(0.7169)	(0.3199)
Log (Min Investment)	-0.0797	-0.1818***	0.0011
	(0.0498)	(0.0575)	(0.0260)
Management Fee	0.1033	-0.0917	0.0252
	(0.0909)	(0.1997)	(0.0703)
Incentive Fee	0.0118	-0.0145	-0.0228***
	(0.0132)	(0.0145)	(0.0071)
High Water Mark	-0.5116**	-0.0618	0.4342***
	(0.2094)	(0.2320)	(0.1143)
Average Leverage	0.0033**	0.0048**	-0.0010*
	(0.0017)	(0.0019)	(0.0006)
Lockup Period	0.0098	-0.0095	-0.0046
	(0.0162)	(0.0199)	(0.0079)
Redemption notice period	0.0069**	0.0063	-0.0003
	(0.0032)	(0.0041)	(0.0019)
Pseudo R-Square	0.0308	0.0508	0.0153
N	518	435	1,636

Table 12: Economic value of tracking the real estate market: Evidence from out-of-sample alphas

This table presents the out-of-sample alphas for the portfolios consisting of funds exposed to different measures of real estate. In each quarter, we form 2 portfolios based on the funds' estimated exposure from the past 24 quarters (i.e., ranking period) and then hold these portfolios. The table reports the out-of-sample seven-factor alphas (in percent per quarter) estimated from the post-ranking returns. Heteroscedasticity and autocorrelation consistent *t*-statistics are reported in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level.

	NAREIT exposure funds	*NCREIF* exposure funds	Spread (*NAREIT - NCREIF*)
Panel A: Full Time period			
NAREIT vs. *NCREIF (NPI)*	0.0074***	0.0049**	0.0025
	(3.40)	(2.12)	(1.60)
NAREIT vs. *NCREIF (TBI)*	0.0074***	0.0053**	0.0021
	(3.40)	(2.19)	(1.21)
Panel B: Sub-period up to September 2008			
NAREIT vs. *NCREIF (NPI)*	0.0090***	0.0065*	0.0025
	(3.23)	(1.97)	(1.68)
NAREIT vs. *NCREIF (TBI)*	0.0090***	0.0071**	0.0019
	(3.23)	(2.20)	(0.71)

Table 13: Economic value of tracking the real estate market: Evidence from out-of-sample alphas

This table presents the out-of-sample alphas for the portfolios consisting of funds at different levels of real estate exposure. In each quarter, we form 2 portfolios based on the funds' estimated exposure from the past 24 quarters (i.e., ranking period) and then hold these portfolios. The table reports the out-of-sample seven-factor alphas (in percent per quarter) estimated from the post-ranking returns. Heteroscedasticity and autocorrelation consistent *t*-statistics are reported in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level.

	Real estate index loading funds	Non real estate index loading funds	Spread (loading-non-loading)
Panel A: Full Time period			
Real estate loading vs. non-real estate loading	0.0052** (2.35)	0.0053** (2.27)	-0.0001 (-0.06)
Panel B: Sub-period up to September 2008			
Real estate loading vs. non-real estate loading	0.0073** (2.39)	0.0064** (2.18)	0.0009 (0.53)

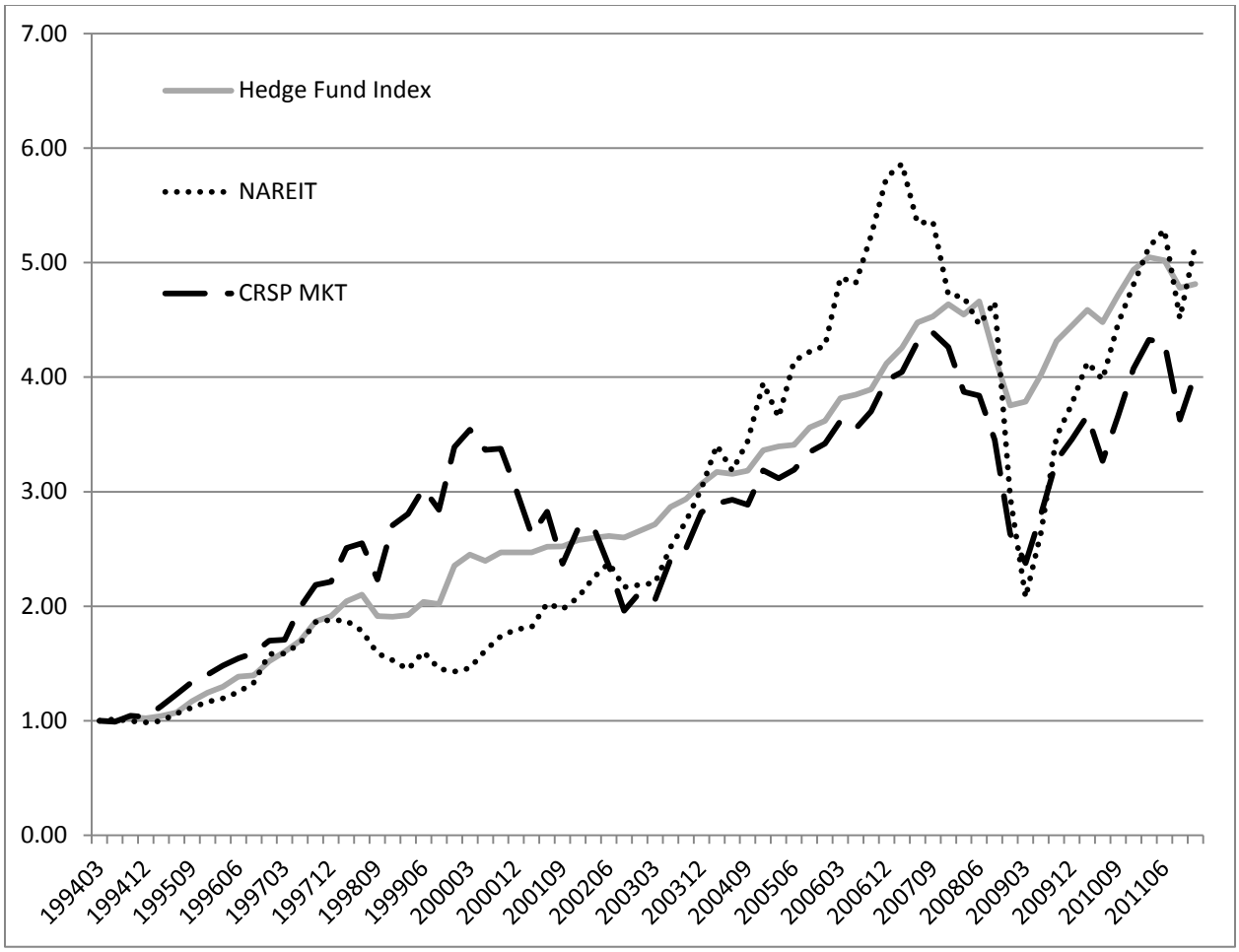

Figure 1: Performance of the *NAREIT, CRSP* market and Hedge fund index.

This figure contrasts the cumulative investment return of the NAREIT index with the performance of the CRSP value weighted market index and a general hedge fund index across diversified strategies.

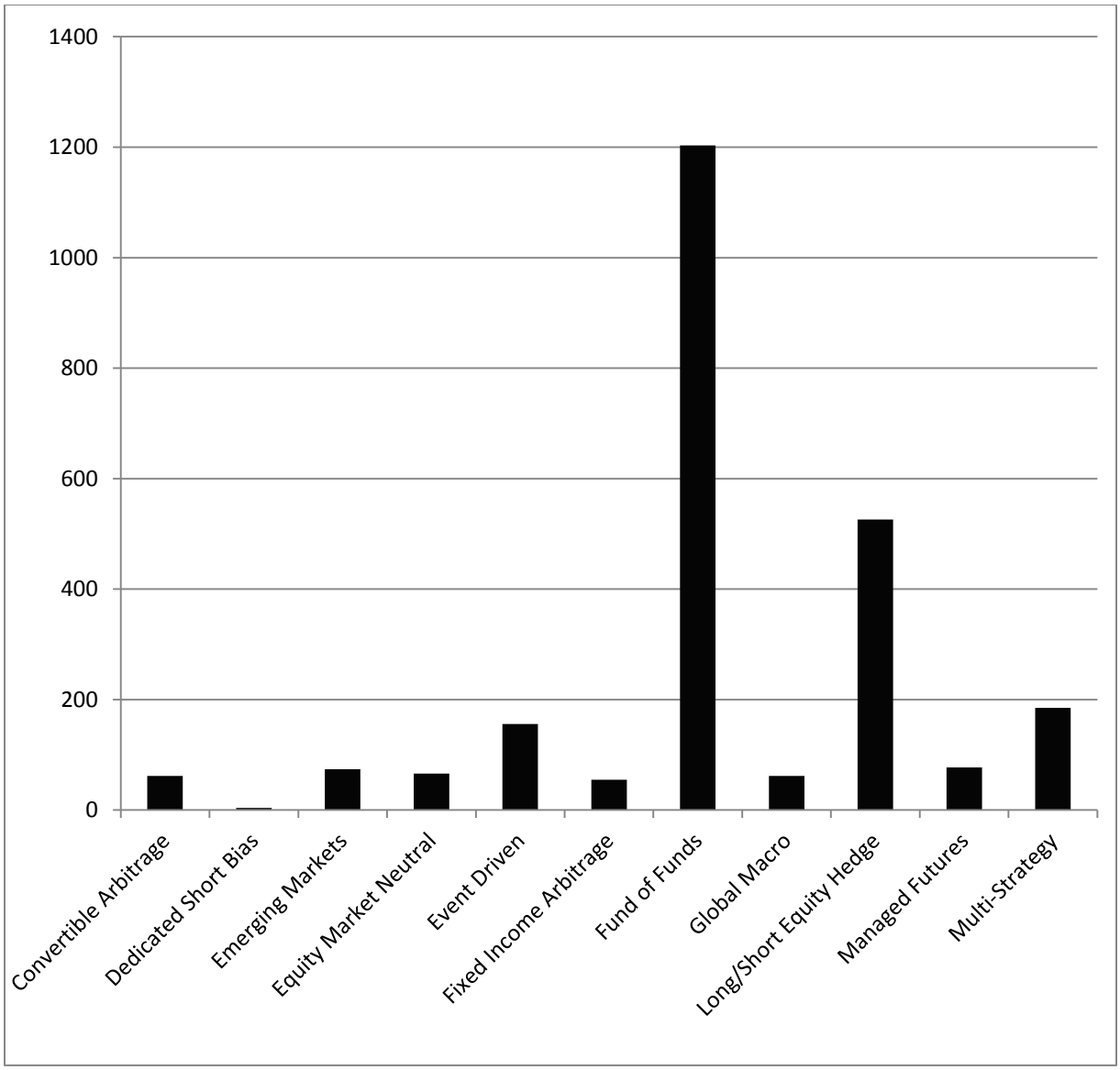

Figure 2: Frequency Distribution of Hedge Funds by Investment Strategy

This figure indicates the strategy description of the entire hedge fund sample of 3,669 funds.

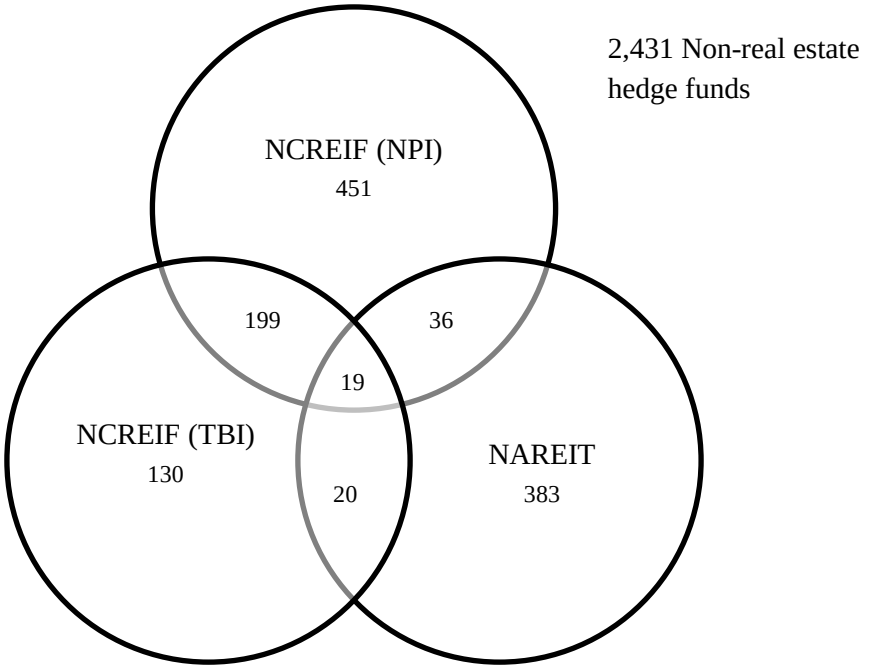

Figure 3: Classification of real estate hedge funds based on estimated exposure.

This figure depicts the number of hedge funds that are either unique or overlap across strategies based on the NAREIT, NCREIF (NPI) and NCREIF (TBI) indexes. NAREIT, NCREIF NPI and NCREIF TBI loading funds are hedge funds that have a statistically significant coefficient on the real estate market factor (RE_MKT) constructed from the NAREIT, NCREIF NPI or NCREIF TBI indexes respectively.

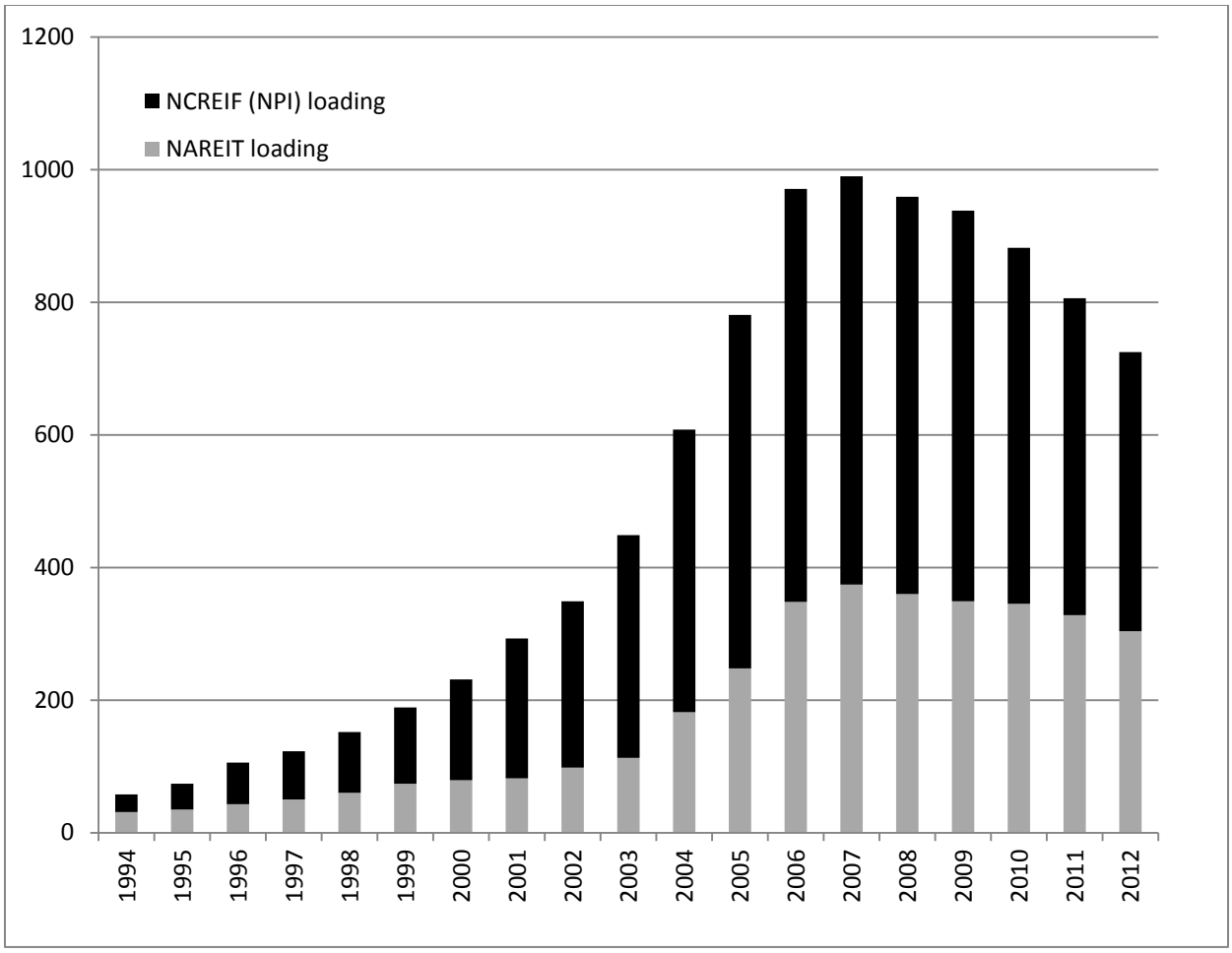

Figure 4: Evolution of real estate hedge funds over time, NAREIT vs. NCREIF (NPI) exposure funds

This figure plots the number of hedge funds that have exposure to the NAREIT or NCREIF (NPI) index. The yearly statistic is the number of hedge funds that exist any time during that year.

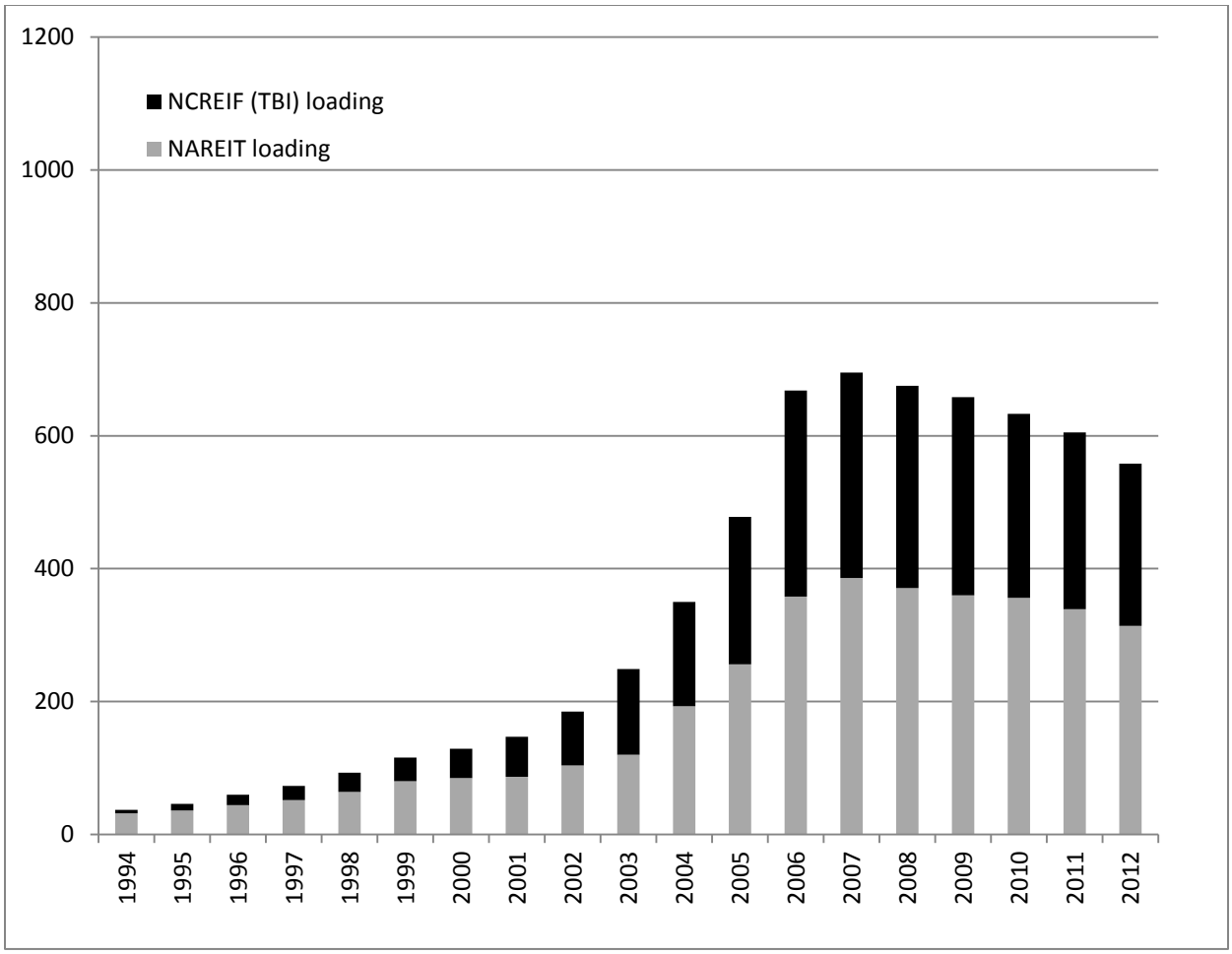

Figure 5: Evolution of real estate hedge funds over time, NAREIT vs. NCREIF (TBI) exposure funds

This figure plots the number of hedge funds that have exposure to the NAREIT or NCREIF (TBI) index. The yearly statistic is the number of hedge funds that exist any time during that year.

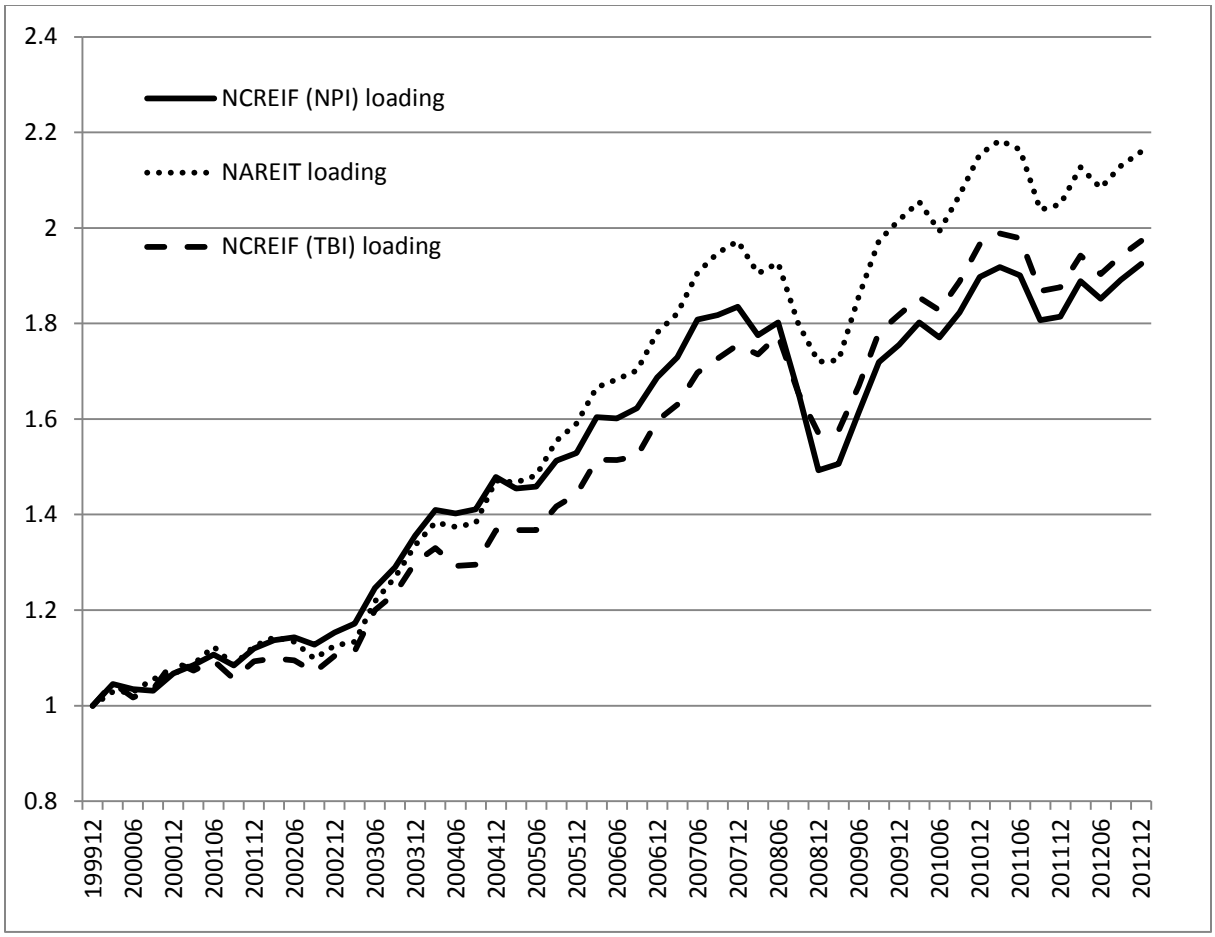

Figure 6: Economic Impact of real estate hedge funds

This figure plots the cumulative returns of portfolios consisting of NCREIF NPI loading , NCREIF TBI loading and NAREIT loading real estate hedge funds. In each quarter starting from December 1999, we form portfolios based on individual hedge funds' real estate exposure, estimated from the previous 24 quarters.

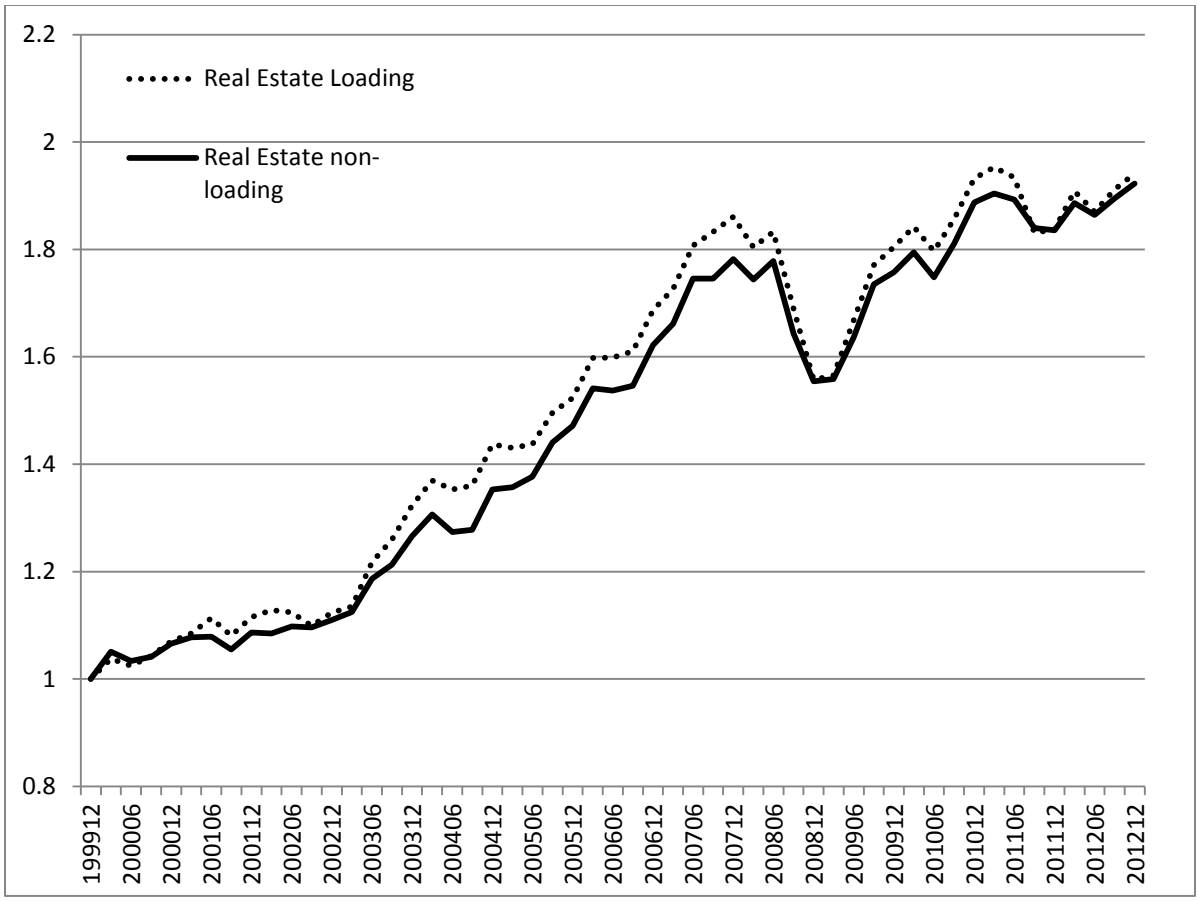

Figure 7: Economic Impact of real estate hedge funds

This figure plots the cumulative returns of portfolios consisting of real estate loading funds (NCREIF NPI, TBI or NAREIT) versus non-loading hedge funds. In each quarter starting from December 1999, we form portfolios based on individual hedge funds' real estate exposure, estimated from the previous 24 quarters.