

# Real Estate Risk and Hedge Fund Returns

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**Abstract** 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 1,321 hedge funds as having significant exposure to direct or securitized real estate. We test for the economic impact of real estate exposure. Our analysis shows that real estate exposure does not increase fund performance.

**Keywords** Hedge funds · Real estate · Performance analysis · Portfolio theory

**JEL Classification** G11 · G12 · R30

## 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

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reluctant to invest without information about how the manager plans to deploy their funds. Thus, 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 with corresponding indexes in an effort to help investors evaluate and benchmark manager performance.

As a result, a large literature has developed surrounding the analysis of hedge funds with respect to these various strategy descriptions and investment styles. Traditionally, researchers focus on developing 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) incorporated option market factors into the traditional multi-factor model to explore the sensitivity of hedge fund returns to dynamic risk.

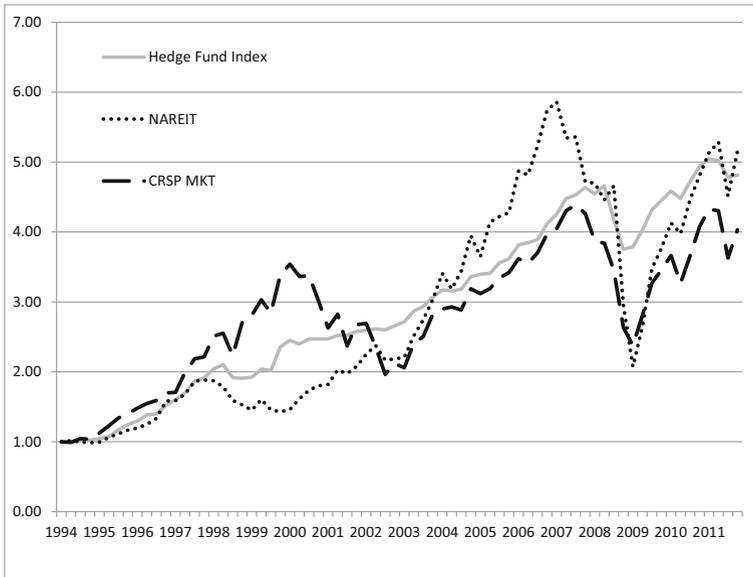
Although the standard hedge fund strategy classifications include broad asset classes (such as fixed income or equities), interestingly, real estate is not listed as one of the common hedge fund investment strategies and to date, most studies have not examined whether a market-wide real estate risk factor exists. Yet, U.S. commercial real estate is a significant asset class valued at approximately \$11.5 trillion as of the end of 2009.<sup>1</sup> In comparison, the value of all publicly traded equity shares at the end of 2009 was approximately \$15.1 trillion.<sup>2</sup> As a result, real estate is often touted as having significant benefits for portfolio diversification and inflation hedging purposes.<sup>3</sup>

Given the size of the real estate market, its performance during the previous decade, 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 indirect real estate investment as captured by sensitivity to real estate investment trusts as measured by the National Association of Real Estate Investment Trusts (NAREIT) index. Our

<sup>1</sup> See Florance et al. (2010) for a detailed estimation of the value of total U.S. commercial real estate property.

<sup>2</sup> CIA *The World Factbook*, <https://www.cia.gov/library/publications/the-world-factbook/geos/us.html>.

<sup>3</sup> 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. In addition, Sirmans and Sirmans (1987), Liu, et al. (1990), Chan et al. (1990), Webb et al. (1992), Grauer and Hakansson (1995), and Peterson and Hsieh (1997) among many provide evidence on the role of real estate in asset allocation and modern portfolio theory. In addition, real estate investments during the previous decade significantly outperformed broader stock market 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 (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>). Figure 1 shows the performance of an equally-weighted hedge fund index across all strategies (available from TASS), the National Association of Real Estate Investment Trusts (NAREIT) index and the CRSP value-weighted market index over the period from 1994 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 indexes. Furthermore, comparing the returns on the generic hedge fund index with the returns on the National Council of Real Estate Fiduciaries property index (NCREIF NPI) indicates a low level of correlation.



**Fig. 1** Performance of the *NAREIT*, *CRSP* market and Hedge fund index. This figure contrasts the cumulative return of the National Association of Real Estate Investment Trusts (*NAREIT*) index with the performance of the *CRSP* value weighted market index and a general hedge fund index across diversified strategies. The sample period is from 1994 to 2012

empirical strategy finds that between 1994 and 2012, 1,321 out of 3,669 funds had significant exposure to real estate assets. Using the bootstrap methodology of Kosowski et al. (2006) and Kosowski et al. (2007), we account for non-normality, heteroskedasticity, and serial correlation to confirm our initial assignments. 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 matched real estate and non-real estate hedge funds that have differential real estate risk exposure but otherwise similar risk characteristics. As a result, any difference between funds with and without real estate exposure can be attributed to the level of real estate risk. We show that funds without real estate exposure are systematically clustered into Emerging Markets, Event Driven, Fixed Income Arbitrage and Managed Futures investment strategies while funds with real estate exposure are not concentrated in any specific strategy classification.

Next, our results indicate that funds with significant real estate exposure have lower minimum investment requirements, 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 lower minimum investment requirements, higher leverage, longer redemption periods, and lower high water marks. These results are consistent with the theory that fund governance structures actively impact individual fund investment allocations. Finally, we evaluate fund performance and find that funds with significant real estate exposure do not contribute to fund performance.

Our results on hedge fund performance and real estate exposure stand in contrast to recent studies examining the performance of alternative investment vehicles. For example, Chung et al. (2012) provide interesting performance benchmarks for private equity funds in their study of management compensation. They report that private equity buyout, venture capital, and real estate funds in their sample generated average annual internal rates of return (IRR) of 16.5, 14.1, and 14.6 %, respectively over the period from 1969 to 2009.<sup>4</sup> In contrast, we find that our empirically identified hedge funds with real estate exposure had mean annual returns of 5.4 % while hedge funds without real estate exposure had annual returns of 7.9 %. Thus, while real estate related hedge funds have lower returns than non-real estate related hedge funds, which mirrors the difference between private equity buyout and private equity real estate funds, hedge fund return levels are lower than private equity fund returns. However, a variety of factors may account for the differences observed between hedge fund and private equity returns. First, private equity funds and hedge funds differ in their underlying investment opportunity sets. Specifically, private equity funds focus on private firms and target long term strategies that are based on relatively illiquid investor mandates. Private equity funds often specialize in leveraged buyout transactions or redevelopment of distressed real estate assets; strategies that require significant active management in the operational details of the asset. In contrast, hedge funds normally invest in traded assets through a range of investment strategies and do not engage in active operational management at the firm or asset level. Second, the various investment strategies employed by hedge funds, such as long-short, may dampen their return volatility. In addition, a number of studies have focused on factors unique to hedge funds to explain differences in their performance. For example, Aragon (2007) presents evidence that suggests that differences in hedge fund share restrictions may result in efficiency gains through an illiquidity constraint while Agarwal et al. (2009) note that differences in managerial incentives can account for differences in hedge fund performance. Third, differences in the methodologies used in measuring private equity IRRs reported in Chung et al. (2012) and hedge fund returns in our sample could also account for differences in the reported return levels.<sup>5</sup>

Our paper proceeds as follows: Section 2 discusses the hedge fund data and Section 3 describes the empirical methodology for identifying funds with real estate exposure. In Section 4, 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

<sup>4</sup> The dataset in Chung, et al. (2012) consists of private equity funds in existence over the period from 1969 to 2009. However, they note that over 90% of their funds come from the 1990 to 2005 subperiod.

<sup>5</sup> The private equity returns reported in Chung et al. (2012) are based on the fund's ultimate performance, after the private equity fund is liquidated. In contrast, our hedge fund returns are based on quarterly filings on the performance of the investments held in the hedge fund portfolio. Thus, our hedge fund return is more closely associated with the "interim IRR" discussed in Chung et al (2012). For real estate investments, the differences between "interim IRR" and final IRR can be substantial as Chung et al (2012) note that the correlation between interim and final IRRs for real estate private equity funds is only 0.228, versus 0.618 for venture capital private equity funds.

real estate exposure and finally provide evidence concerning the performance of funds with and without real estate exposure.

## 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 mitigates the survivorship bias. The TASS database allows us to track the monthly returns on funds net of all fees (management, incentive and other expenses). 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 the fund’s introduction to the database. To ensure meaningful analysis we also exclude funds that have less than 24 quarters of return observations. Thus, our final sample comprises 3,669 funds.

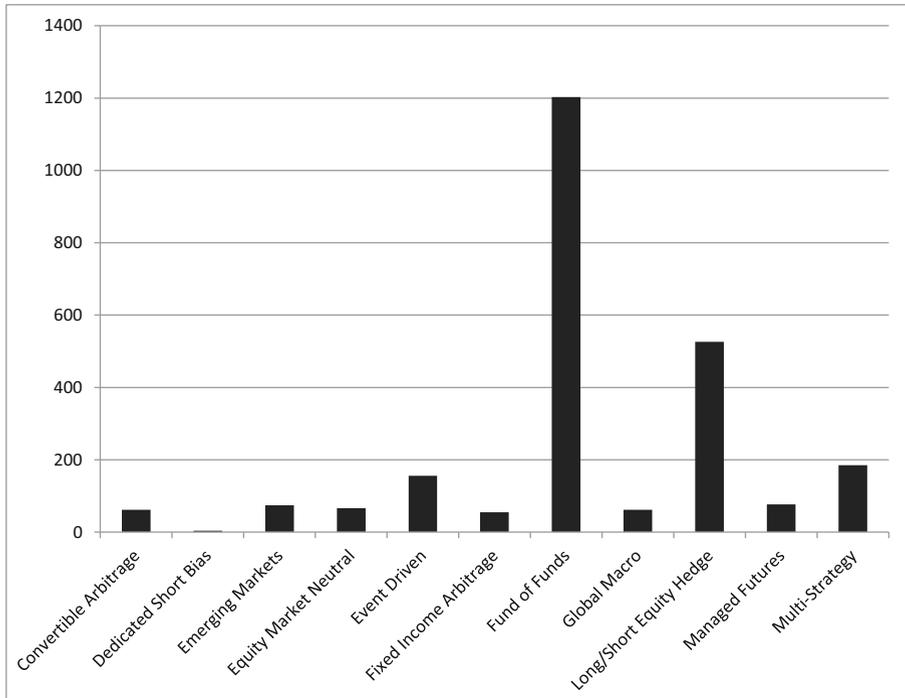
TASS classifies individual hedge funds into eleven strategy categories: convertible arbitrage, dedicated short bias, emerging markets, equity market neutral, event driven, fixed income arbitrage, fund of funds, global macro, long-short equity, managed futures, and multi-strategy.<sup>6</sup> We retain 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.

In addition to individual fund level investment strategy data, TASS reports individual fund characteristics. TASS 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. For funds that use leverage, TASS further reports the use of futures, derivatives, margin borrowing, or foreign exchange credit. 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.

We use two sources as a proxy for real estate investment performance. First, we utilize the FTSE/NAREIT US Real Estate Index to track the performance of securitized real estate investments available through equity investments in real estate investment trusts (REITs). This index is a market capitalization weighted index that spans the commercial

<sup>6</sup> The Appendix provides a detailed description of these strategies.



**Fig. 2** Frequency Distribution of Hedge Funds by Investment Strategy. This figure plots the number of hedge funds in each strategy category. The TASS database classifies individual hedge funds into eleven strategies: convertible arbitrage, dedicated short bias, emerging markets, equity market neutral, event driven, fixed income arbitrage, funds of funds, global macro, long/short equity, managed futures, and multi-strategy

real estate markets as reflected by REITs listed on the New York Stock Exchange, the American Stock Exchange, and the NASDAQ National Market List. Second, we use the National Council of Real Estate Investment Fiduciaries (NCREIF) Property Index to track the performance of direct investment in institutional-grade commercial real estate investments. The NAREIT index represents variation in the highly liquid securitized market. The NCREIF Property Index measures the quarterly total return of a pool of commercial properties acquired by tax-exempt institutional investors for investment purposes only. Individual property returns are calculated net of property management fees but before portfolio-level management fees and are weighted by the property's market value. Hence, we use the NCREIF index to proxy for investments in the direct real estate market.

## 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 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 to examine 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 strategies.<sup>7</sup> Thus, we augment their factor model to include a real estate factor as follows:

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

where  $r_{i,t} - r_{f,t}$  is the net-of-fee excess return of fund  $i$  in quarter  $t$  and  $r_{f,t}$  is the quarterly return on the 30-day Treasury bill rate;  $MKT$  is the CRSP value-weighted index (VWRETD) return less the 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 10-year treasury constant maturity yield;  $BAAMSTY$  is the change in the credit spread defined as 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<sup>8</sup>;  $RE\_MKT$  represents a real estate market factor (defined below).

To the extent that real estate investments are affected by the other equity and bond market factors, Eq. (1) will be over identified. Thus, we estimate a real estate market factor based on the residual from the following regression of the real estate market excess return (NAREIT, NCREIF NPI) on the Fung-Hsieh seven factors:

$$RE\_INDEX_t - r_{f,t} = \delta_0 + \delta_1MKT_t + \delta_2SMB_t + \delta_3YLDCHG_t + \delta_4BAAMSTY_t + \delta_5PTFSBD_t + \delta_6PTFSFX_t + \delta_7PTFSCOM_t + \eta_t \quad (2)$$

where  $RE\_INDEX - r_{f,t}$  is the excess return of the *NAREIT* or *NCREIF NPI* index. The residual represents an orthogonal real estate specific component that is not explained by the movements in the general equity and bond markets and is uncorrelated with the stock market factor ( $MKT$ ) and other Fung-Hsieh factors. We set the real estate factor to be the residual from Eq. (2) and classify hedge funds that have a statistically significant coefficient (at the 1 % level) on the real estate market factor ( $RE\_MKT$ ) in Eq. (1) as hedge funds with real estate exposure. All data used in the regression analysis are quarterly data since the data of the NCREIF index is only available at quarterly frequency.

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 value weighted – annual return of 9.64 %) is lower than that of the NAREIT index (annual return of 11.96 %), implying a potential differential economic impact between portfolios comprising of the stock market and real estate market.<sup>9</sup> Additionally, the average

<sup>7</sup> 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.

<sup>8</sup> We thank William Fung and David Hsieh for making their factor data available at: <http://faculty.fuqua.duke.edu/~dah7/DataLibrary/TF-FAC.xls>

<sup>9</sup> NAREIT index return data is obtained from REIT.com. While REIT index return data is available across sectors, we use the NAREIT All REITs index return to capture the variation across the entire securitized real estate market.

**Table 1** Summary statistics of factor data

	Mean	STD	25 %	75 %
Panel A: Market index return				
CRSP	9.64	36.54	-8.05	31.91
NAREIT	11.96	40.34	-4.37	35.32
NCREIF (NPI)	9.06	9.48	7.34	13.96
Panel B: Fung-hsieh factors				
SMB	2.18	17.94	-8.01	11.74
YLDCHG	-0.21	2.14	-1.72	1.54
BAAMSTY	0.05	1.87	-0.88	0.56
PTFSBD	-12.87	132.69	-102.60	37.84
PTFSFX	-5.82	139.44	-101.39	79.39
PTFSCOM	-8.28	87.49	-69.04	42.40

This table reports annual summary statistics of the *CRSP* value weighted market return, the National Association of Real Estate Investment Trusts (*NAREIT*) index return, and the National Council of Real Estate Fiduciaries (*NCREIF NPI*) index return, as well as the Fung-Hsieh factors including 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.

return of direct investments in real estate (*NCREIF NPI* index – annualized return of 9.06 %) is lower than that of the securitized real estate market (*NAREIT* – annual return of 11.96 %). We also summarize the Fung-Hsieh factors over the sample time period for reference. Table 2 reports the correlations between the *NCREIF NPI* index, *NAREIT* index and the Fung-Hsieh factors. While the *NCREIF NPI* index and *NAREIT* index are positively correlated, the *NCREIF NPI* index is not significantly correlated with the Fung-Hsieh factors. In contrast, the *NAREIT* index is correlated with several of the Fung-Hsieh factors. As a result, we create an orthogonal real estate component to allow for a source of variation that is uncorrelated with the Fung-Hsieh factors.

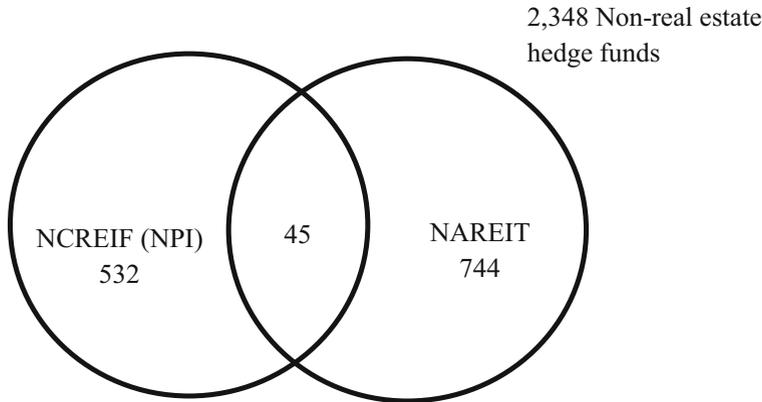
Figure 3 presents the classification of hedge funds that have significant real estate factor loadings from the estimation of Eq. (1). Out of the 3,669 hedge funds in our sample, we find that 1,321 funds have a significant loading on one of the real estate factors, and thus are classified as “funds with real estate exposure”. The remaining 2,348 funds have an insignificant loading on the real estate factors and thus are classified as “funds without real estate exposure”. Out of the 1,321 “real estate funds” we see that 532 funds have exposure to the *NCREIF NPI* index only and 744 to the *NAREIT* index only. We also find that only 45 hedge funds have exposure to the *NCREIF NPI* and the *NAREIT* index suggesting that investment in direct real estate (*NCREIF*) versus securitized real estate (*NAREIT*) is somewhat mutually exclusive.<sup>10</sup> Overall, our identification strategy reveals that a large number (36 %) of hedge funds have exposure to the direct or indirect real estate market.

<sup>10</sup> Overall, we note on Table 2 that 789 funds have exposure to the *NAREIT* index (744+45) and 577 funds have exposure to the *NCREIF* index (532+45).

**Table 2** Correlation statistics of factor data

	NCREIF (NPI)	NAREIT	MKT	SMB	YLDCHG	BAA MSTY	PTFSBD	PTFSFX	PTFSCOM
NCREIF (NPI)	1.00								
NAREIT	0.21*	1.00							
MKT	0.17	0.60***	1.00						
SMB	-0.11	0.56***	0.43***	1.00					
YLDCHG	0.01	0.24**	0.48***	0.35***	1.00				
BAA MSTY	0.04	-0.55***	-0.68***	-0.46***	-0.73***	1.00			
PTFSBD	-0.12	-0.33***	-0.34***	-0.13	-0.34***	0.38***	1.00		
PTFSFX	-0.02	-0.15	-0.28**	-0.16	-0.39***	0.44***	0.19	1.00	
PTFSCOM	0.08	-0.26**	-0.30**	-0.31**	-0.28**	0.38***	0.28**	0.47***	1.00

This table reports the correlations of the National Council of Real Estate Fiduciaries (NCREIF NPI) index return, the National Association of Real Estate Investment Trusts (NAREIT) index return, the CRSP value weighted market return, as well as the Fung-Hsieh factors including 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 (BAA MSTY), and three trend-following factors: PTFSBD (bond), PTFSFX (currency), PTFSCOM (commodity). The sample period is from January 1994 to December 2012. \*, \*\*, \*\*\* indicate significance at the 10, 5, and 1 % level



**Fig. 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 and NCREIF NPI indexes. NAREIT and NCREIF NPI loading funds are hedge funds that have a statistically significant coefficient (at the 1 % level) on the real estate market factor (RE\_MKT) constructed from the NAREIT and NCREIF NPI indexes respectively. Among 3,669 hedge funds in our sample, 1,321 are classified as hedge funds with significant real estate exposure and 2,348 are classified as hedge funds without real estate exposure

Next, we turn to an analysis of the differences in returns for funds with or without real estate exposure. Table 3 reports summary statistics of average annual returns of hedge funds across the real estate strategy classifications. We see that our empirically identified funds with real estate exposure have a mean annual return of 5.42 % while funds without real estate exposure had a return of 7.90 % per year. Although funds with real estate exposure had a lower average return, we also note that they had a lower standard deviation (24.37 % versus 27.48 %). Examining the funds with real estate exposure based on the individual factor loading, we see that NAREIT loading hedge funds had a mean return of 5.66 %. In comparison, NCREIF NPI loading funds had a mean return of 5.21 %.

Figure 4 shows 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 suggests that funds have increased 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 of 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, we find that a large number of hedge funds have exposure to the direct and securitized real estate market.

## Empirical Results

### Empirical Results on the Real Estate Factors

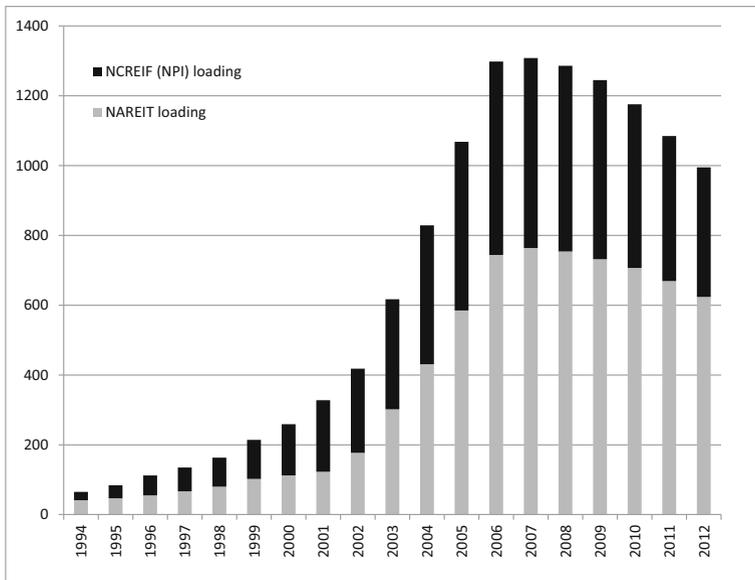
In this section, we present two checks on the veracity of using the NCREIF and NAREIT indexes as factors to capture hedge fund exposure to real estate investments. First, we present the cross-sectional distribution of the real estate market factor's coefficient (*t*-statistic) across individual funds for different subsets of the data. Second, we use the detailed strategy descriptions provided by TASS to identify funds that explicitly state that they invest in real estate assets (either debt or equity) in order to create additional real estate

**Table 3** Summary statistics of average returns on real estate oriented hedge funds

	N	Mean	STD	25 %	75 %
Panel A: All hedge funds					
All funds	3,669	7.07	26.51	-2.96	17.02
Non real estate funds	2,348	7.90	27.48	-2.67	18.01
Real estate funds	1,321	5.42	24.37	-3.42	15.18
Panel B: Real estate hedge funds					
NAREIT loading funds	789	5.66	25.20	-4.84	16.17
NCREIF (NPI) loading funds	577	5.21	23.27	-1.91	14.13

This table presents summary statistics of average annual returns of real estate and non-real estate loading hedge funds. N is the number of funds that exist any time during the sample period. NAREIT loading funds are hedge funds that have a 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 significant coefficient on the real estate market factor (RE\_MKT) constructed from the NCREIF NPI index. Funds with real estate exposure are hedge funds that have a significant coefficient on the real estate market factor (RE\_MKT) constructed from the NAREIT or NCREIF NPI index

based style indexes. Our analysis contrasts the percent variation in the returns of real estate hedge funds explained by the real estate factors against that of standard hedge fund index returns. We then compare the extent that the NCREIF and NAREIT factors are able to explain the returns on the various indexes. Combined, these analyses provide aggregate index level and individual fund level results that verify the efficacy of the real estate factors.



**Fig. 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

*Bootstrap Analysis*

To address the concern that fund level regressions implicitly assume normality of return data, which may result in inaccurate inference about the significance of the real estate market factor in the estimated model, we follow the Kosowki et al. (2006) and Kosowski et al. (2007) bootstrap methodology to account for non-normality, heteroskedasticity, and serial correlation in hedge fund returns. Specifically, 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 results 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*) for individual hedge funds we implement the following bootstrap procedure for each fund<sup>11</sup>:

- Step 1 Estimate the 8-factor model (Eq. (1)) for fund *i* 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  $\{\hat{\varepsilon}_{i,t}^b, t = 1, \dots, T_i\}$ . *t*-statistics are based on heteroscedasticity and autocorrelation consistent standard error estimates. *b* refers to the index of the bootstrap simulation ( $b=1, 2, \dots, 1,000$ ).
- Step 2 From the residuals saved from the first step, draw a random sample with replacement to obtain a time series of resampled residuals  $\{\hat{\varepsilon}_{i,t}^b, t = s_1^b, s_2^b, \dots, s_{T_i}^b\}$ . Then for each bootstrap iteration *b*, we construct a time series of quarterly excess returns by imposing the null hypothesis of zero exposure to the real estate market factor.

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

- Step 3 Regress the bootstrapped quarterly returns on the 8-factor model in Eq. (1). If the coefficient of the real estate market factor is not zero, then it is the result of purely sampling variation as the null hypothesis of no fund level real estate exposure is imposed.
- Step 4 Repeat steps two and three for each fund and store the cross-sectional statistics (e.g., the top 5<sup>th</sup> percentile) of the coefficients of the real estate market factor and their *t*-statistics across all sample funds.
- Step 5 Repeat steps one through four 1,000 iterations in order to obtain the empirical distribution for the cross-sectional statistics (e.g., the top 5<sup>th</sup> percentile) of *t*-statistics.

For a given cross-sectional statistic, we obtain its empirical p-value as the frequency that the values of the bootstrapped cross-sectional statistic for the pseudo funds from 1,000 iterations exceed the actual value of the cross-sectional statistic. If the bootstrap

<sup>11</sup> 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.

distributions generate fewer extreme values for the real estate market factor coefficient than those observed in the actual data, then it would suggest that sampling variation is not the sole source of the empirical observation of fund level real estate exposure, but rather the portfolios are genuinely sensitive to real estate.

Table 4 displays the results for the hedge funds that have exposure to the NAREIT and NCREIF NPI 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-ranked" funds with real estate exposure cannot be attributed to sampling variation. The bootstrapped  $p$ -values of the top (1st, 5th, and 10th) percentile funds are zero, 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 and NCREIF NPI indexes.

### *Efficacy of Real Estate Factors*

Our primary analysis augments the Fung-Hsieh factor model by introducing a real estate specific factor constructed from the NAREIT and NCREIF indexes, 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 use key real estate terms in conjunction with the detailed strategy description provided in the TASS hedge fund database to identify 45 non-debt and 91 debt related hedge funds that explicitly indicate a real estate investment strategy. For example, we identify real estate funds if the TASS description contains words such as real estate, mortgage-backed securities (MBS), or property. We use these funds to create two new indexes that we call "real estate debt" and "real

**Table 4** Statistical significance of individual fund level real estate exposure based on the bootstrapped method

	Bottom			Top		
	1 %	5 %	10 %	10 %	5 %	1 %
789 NAREIT loading funds						
t-statistic	-7.29	-5.92	-5.14	-2.84	3.06	4.68
Bootstrapped p-value	0.00	0.00	0.00	0.00	0.00	0.00
577 NCREIF NPI loading funds						
t-statistic	-6.13	-4.92	-4.10	4.84	5.59	7.59
Bootstrapped p-value	0.00	0.00	0.00	0.00	0.00	0.00

This table presents the statistical significance of real estate exposure for *NAREIT* loading funds and *NCREIF NPI* loading funds. The real estate market factor's coefficient is estimated relative to the Fung-Hsieh factors. *NAREIT* and *NCREIF NPI* loading funds are hedge funds that have a statistically significant coefficient on the real estate market factor ( $RE\_MKT$ ) constructed from the *NAREIT* and *NCREIF NPI* indexes, respectively. We 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. The results are reported for the top and bottom 1, 5, and 10 % funds, according to the  $t$ -statistic of the coefficient estimate of the real estate market factor

estate non-debt”. We then estimate a regression of the returns of the various TASS identified indexes and the two real estate terms indexes on the conventional 7-factor model and the complete 8-factor real estate model. If the real estate factors constructed from the NAREIT and NCREIF NPI indexes 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 these real estate factors.

Tables 5 and 6 report the adjusted R-squares from the estimation of the 7-factor and 8-factor models using returns from January 1994 to September 2008 for a variety of hedge fund indexes. A statistical breakpoint analysis of the complete time series (1994 to 2012) identifies September 2008 as a significant time point that divides the series into sub-periods. This is intuitive as it coincides with the period immediately before the highest

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

Portfolio	Adjusted R <sup>2</sup> 7-factor model	Adjusted R <sup>2</sup> 8-factor model	Ratio of Adjusted R <sup>2</sup> (7-factor /8-factor NAREIT model)
Real estate non-debt	0.33	0.53	0.62
Real estate debt	0.22	0.21	1.04
Hedge fund index	0.50	0.49	1.02
Convertible arbitrage	0.20	0.19	1.05
Dedicated short bias	0.73	0.73	1.00
Emerging markets	0.36	0.35	1.03
Equity market neutral	0.02	0.02	1.00
Event driven	0.58	0.58	1.00
Fixed income arbitrage	0.31	0.30	1.03
Global macro	0.18	0.16	1.13
Long short equity	0.58	0.63	0.92
Managed futures	0.19	0.18	1.06
Multi strategy	0.23	0.21	1.10

This table reports the adjusted R<sup>2</sup> and ratio of adjusted R<sup>2</sup> of a 7-factor model to the adjusted R<sup>2</sup> of the full 8-factor model for 13 hedge fund index portfolios. Time series regressions of the 7-factor and 8-factor models are as follows:  $r_{i,t} - r_{f,t} = \alpha_i + \beta_{i,1}MKT_t + \beta_{i,3}SMB_t + \beta_{i,4}YLDCHG_t + \beta_{i,5}BAAMSTY_t + \beta_{i,6}PTFSBD_t + \beta_{i,7}PTFSFX_t + \beta_{i,8}PTFSCOM_t + \varepsilon_{i,t}$

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

The dependent variable  $r_{i,t} - r_{f,t}$  is the quarterly 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

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

Portfolio	Adjusted R <sup>2</sup> 7-factor model	Adjusted R <sup>2</sup> 8-factor model	Ratio of Adjusted R <sup>2</sup> (7-factor /8-factor NCREIF NPI model)
Real estate non-debt	0.33	0.35	0.94
Real estate debt	0.22	0.30	0.73
Hedge fund index	0.50	0.49	1.02
Convertible arbitrage	0.20	0.19	1.05
Dedicated short bias	0.73	0.73	1.00
Emerging markets	0.36	0.35	1.03
Equity market neutral	0.02	0.02	1.00
Event driven	0.58	0.57	1.02
Fixed income arbitrage	0.31	0.32	0.97
Global macro	0.18	0.17	1.06
Long short equity	0.58	0.58	1.00
Managed futures	0.19	0.22	0.86
Multi strategy	0.23	0.26	0.88

This table reports the adjusted R<sup>2</sup> and ratio of adjusted R<sup>2</sup> of a 7-factor model to the adjusted R<sup>2</sup> of the full 8-factor model for 13 hedge fund index portfolios. Time series regressions of the 7-factor and 8-factor models are as follows:  $r_{i,t} - r_{f,t} = \alpha_i + \beta_{i,1}MKT_t + \beta_{i,3}SMB_t + \beta_{i,4}YLDCHG_t + \beta_{i,5}BAAMSTY_t + \beta_{i,6}PTFSBD_t + \beta_{i,7}PTFSFX_t + \beta_{i,8}PTFSCOM_t + \varepsilon_{i,t}$   
 $r_{i,t} - r_{f,t} = \alpha_i + \beta_{i,1}MKT_t + \beta_{i,2}RE\_MKT_t + \beta_{i,3}SMB_t + \beta_{i,4}YLDCHG_t + \beta_{i,5}BAAMSTY_t + \beta_{i,6}PTFSBD_t + \beta_{i,7}PTFSFX_t + \beta_{i,8}PTFSCOM_t + \varepsilon_{i,t}$

The dependent variable  $r_{i,t} - r_{f,t}$  is the quarterly 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* 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

decline in the NAREIT and NCREIF indexes. Hence, we focus on the time period from 1994 to 2008 to avoid any correlation inherent in the index returns after the crisis.

Table 5 presents results showing the incremental variation explained by the real estate factor. To show the impact of the real estate factor, we calculate the ratio of the 7-factor model adjusted R-square to the 8-factor model adjusted R-square. The ratio of the adjusted R-squares for the real estate non-debt related hedge funds is 0.62 indicating that the real estate factor based on the NAREIT index does indeed have significant explanatory power. On the contrary, the ratio of the adjusted R-squares is close to one for the real estate debt related hedge funds and funds in each strategy category, 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.

Next, Table 6 presents results showing the incremental variation explained by the real estate factor based on the NCREIF NPI index. For the real estate debt hedge funds, the adjusted R-square from the 7-factor model is 0.22, while the adjusted R-square from the 8-factor model is 0.30. The ratio of the two adjusted R-squares is 0.73, and the improvement in the fitting result (e.g., the 8-factor model over the 7-factor model) is significant. For the strategies of Managed Futures and Multi-Strategy, we also note that including the NCREIF NPI based real estate factor improves the fitting result of the 7-factor model. However, for the other hedge fund strategies, adding the NCREIF NPI index does not lead to a significant improvement in the fitting result as the ratios of the 7-factor and the 8-factor models are close to one.

Overall, this section presents evidence that the NAREIT or NCREIF NPI based factors explain the returns of hedge funds that explicitly follow a real estate investment strategy. Taken together, the construction of the real estate market factor and its relation with various diversified hedge fund index returns points to the existence of a real estate component that explains the returns of hedge funds that follow a real estate investment strategy.

### Do Hedge Fund Strategies Systematically Use Real Estate Investments?

Using our empirical identification of funds that follow a real estate investment strategy, we now focus on answering the question: Do certain hedge fund strategies systematically use real estate investments? However, 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 use a one-to-one matched sample 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. Specifically, we perform the following matching procedure:

- Step 1 For each hedge fund among the group of real estate loading funds, estimate the Fung-Hsieh 7-factor model and preserve betas of each factor.
- Step 2 Estimate the 7-factor model for each non-real estate loading hedge fund and retain the betas corresponding to each risk factor.
- Step 3 For a given fund  $i$  in the group of real estate loading funds, compute the distance score statistic for each fund  $j$  in the group of funds without real estate exposure:

$$\begin{aligned}
 Score_{i,j} = & \left( \frac{\beta_{MKT,i} - \beta_{MKT,j}}{0.5(\beta_{MKT,i} + \beta_{MKT,j})} \right)^2 + \left( \frac{\beta_{SMB,i} - \beta_{SMB,j}}{0.5(\beta_{SMB,i} + \beta_{SMB,j})} \right)^2 \\
 & + \left( \frac{\beta_{YLDCHG,i} - \beta_{YLDCHG,j}}{0.5(\beta_{YLDCHG,i} + \beta_{YLDCHG,j})} \right)^2 + \left( \frac{\beta_{BAAMSTY,i} - \beta_{BAAMSTY,j}}{0.5(\beta_{BAAMSTY,i} + \beta_{BAAMSTY,j})} \right)^2 \\
 & + \left( \frac{\beta_{PTFSBD,i} - \beta_{PTFSBD,j}}{0.5(\beta_{PTFSBD,i} + \beta_{PTFSBD,j})} \right)^2 + \left( \frac{\beta_{PTFSFX,i} - \beta_{PTFSFX,j}}{0.5(\beta_{PTFSFX,i} + \beta_{PTFSFX,j})} \right)^2 \\
 & + \left( \frac{\beta_{PTFSCOM,i} - \beta_{PTFSCOM,j}}{0.5(\beta_{PTFSCOM,i} + \beta_{PTFSCOM,j})} \right)^2
 \end{aligned} \tag{4}$$

**Table 7** Percentages of real estate loading funds in each strategy category: a matched sample comparison

	Real estate loading funds (%)	Matched Non-real estate loading funds (%)	Difference ( <i>p</i> -value)
Convertible arbitrage	2.05	1.83	(0.67)
Dedicated short bias	0.00	0.23	(0.25)
Emerging markets	2.21	4.49	(0.00)
Equity market neutral	2.28	2.43	(0.80)
Event driven	4.56	7.30	(0.00)
Fixed income arbitrage	1.52	2.59	(0.05)
Fund of funds	54.83	46.77	(0.00)
Global macro	2.21	1.67	(0.32)
Long/Short equity hedge	20.23	20.08	(0.92)
Managed futures	3.80	5.17	(0.09)
Multi-strategy	6.31	7.45	(0.25)
N	1,315	1,315	

For the pair-wise sample of 1,315 funds with real estate exposure and 1,315 funds without real estate exposure, we report the percentages of funds in each strategy category. Funds that load on the NAREIT or NCREIF NPI residual factors are classified as funds with real estate exposure. Funds without real estate exposure do not load on any of the two real estate measures. The values in the second and third columns are percentage of funds that correspond to the investment strategy in the first column. N is the number of funds. The last column indicates the *p*-value of the Z-test for equality of proportions for columns indicated. The number of matched funds is based on a one to one matching procedure. Hence, we have 1,315 matched funds with and without real estate exposure that satisfy the matching rule

- Step 4 Select fund  $j^*$  that yields the lowest score,  $j^* \in [1, 2, \dots, J]$  and classify funds  $i, j^*$  as a matched pair.
- Step 5 Repeat steps 1-4 for each fund  $i$  in the group of real estate loading funds with replacement for fund  $j$ .

The procedure matches one-for-one 1,315 real estate hedge funds with 1,315 non real estate hedge funds. Additionally, we contrast 532 NCREIF NPI loading with 532 NAREIT loading funds.<sup>12</sup> The 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 strategy classification that have significant real estate factor loadings. In 5 out of the 11 classification categories, real estate fund representation differs from the matched sample of funds without real estate exposure. We find that a higher proportion of funds without real estate exposure follow the “Emerging Markets”, “Event Driven”, “Fixed Income Arbitrage” and “Managed Futures” strategies. Also, a larger proportion of funds with

<sup>12</sup> The number of matched funds is based on a one-to-one matching procedure. Hence, we have 1,315 matched funds with real estate exposure, and 532 matched NCREIF NPI loading and NAREIT loading funds that satisfy the matching rule. Six funds have multiple matches with non-real estate funds and thus are excluded from the analysis in this section.

real estate exposure follow the “Fund of Funds” strategy. As a result, it appears that the real estate loading funds are not clustered primarily among any specific strategy classification.

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 (NCREIF based) versus indirect (NAREIT based) real estate exposure for those matched funds that are classified as funds with real estate exposure. We report percentages of hedge funds that load on the NCREIF NPI based factor and on the NAREIT based factor. We find that 51.9 % of hedge funds that are classified as having exposure to direct real estate (NCREIF) have an investment strategy classification of “Fund of funds”. This increases to 58.3 % for funds that load on the NAREIT based factor. Furthermore, we see that 13.7 % of the “Long/Short Equity Hedge” funds with significant real estate exposure load on the direct real estate factor while 24.4 % load on the NAREIT factor. In contrast, we see that funds with significant real estate exposure that are classified as “Convertible Arbitrage”, “Event Driven”, “Fixed Income Arbitrage”, 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. In conclusion, while the comparison of funds across levels of real estate exposure reveals a differential classification over hedge fund strategies, the empirical strategy reveals that hedge funds that follow a real estate strategy are not predominantly classified in any specific strategy.

**Table 8** Percentages of real estate loading funds in each strategy category: NCREIF versus NAREIT indexes

	NCREIF loading (NPI) funds (%)	NAREIT loading funds (%)	Difference (p-value)
Convertible arbitrage	4.32	0.75	(0.00)
Dedicated short bias	0.00	0.00	(1.00)
Emerging markets	2.44	3.76	(0.22)
Equity market neutral	2.63	1.50	(0.20)
Event driven	7.71	2.82	(0.00)
Fixed income arbitrage	3.01	0.00	(0.00)
Fund of funds	51.88	58.27	(0.04)
Global macro	2.44	1.32	(0.18)
Long/Short equity hedge	13.72	24.44	(0.00)
Managed futures	3.57	1.13	(0.01)
Multi-strategy	8.27	6.02	(0.15)
N	532	532	

For each strategy category, this table presents percentages of funds with significant loading on the NCREIF index and on the NAREIT index respectively. The values in the second and third columns are percentage of funds that correspond to the investment strategy in the first column. N is the number of funds. The last column indicates the *p*-value of the Z-test for equality of proportions for columns indicated. The number of matched funds is based on a one to one matching procedure. Hence, we have 532 matched NCREIF NPI loading and NAREIT loading funds that satisfy the matching rule

**Table 9** Comparison of characteristics between real estate and non-real estate hedge funds: A matched sample approach

	Real estate funds (%)	Non-real estate funds (%)	Difference ( <i>p</i> value)
Leveraged	47.07	46.46	(0.76)
Futures	12.83	16.82	(0.02)
Derivatives	14.01	17.61	(0.04)
Margin	30.88	31.15	(0.92)
FX credit	8.31	8.01	(0.86)
Personal capital	17.19	25.32	(0.00)

This table presents the characteristics of funds with and without real estate exposure. Funds that load on the NAREIT and NCREIF NPI are classified as funds with real estate exposure. Funds without real estate exposure do not load on any of the two real estate measures. The values in the second and third columns are percentage of funds that correspond to the characteristic in the first column. The last column indicates the *p*-value of the Z-test for equality of proportions for columns indicated. The number of matched funds is based on a one to one matching procedure. Hence, we have 1,315 matched funds with and without real estate exposure that satisfy the matching rule

### 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. Tables 9 and 10 contrast the characteristics of real estate and non-real estate hedge funds. Specifically, 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 find that funds without real estate exposure are as equally leveraged (47 versus 46 %) as the funds with real estate exposure. Non-real estate funds are more likely to use futures contracts (17 versus 13 %) and derivatives (18 versus 14 %) than funds with real estate exposure. Additionally, we find a higher occurrence of principals investing

**Table 10** Comparison of characteristics between funds loaded on the NCREIF and NAREIT index

	NCREIF NPI funds (%)	NAREIT loading funds (%)	Difference ( <i>p</i> -value)
Leveraged	49.25	40.41	(0.00)
Futures	11.17	13.55	(0.34)
Derivatives	13.35	15.06	(0.52)
Margin	31.06	27.11	(0.25)
FX credit	9.26	11.14	(0.41)
Personal capital	19.36	17.11	(0.34)

This table presents the characteristics of real estate hedge funds and contrasts funds that load on the NCREIF (NPI) residual or NAREIT residual factors. The values in the second and third columns are percentage of funds that correspond to the characteristic in the first column. The last column indicates the *p*-value of the Z-test for equality of proportions for columns indicated. The number of matched funds is based on a one to one matching procedure. Hence, we have 532 matched NCREIF NPI loading and NAREIT loading funds that satisfy the matching rule

personal capital in funds without real estate exposure (25 %) versus funds with real estate exposure (17 %).

Table 10 reports similar comparisons between funds with real estate exposure that have exposure to direct (NCREIF) or indirect (NAREIT) real estate. NCREIF loading funds are more leveraged (49 versus 40 %) than NAREIT loading funds. The test-statistics for the differences in proportions for the rest of the fund characteristics are not significant. The overall conclusion is that hedge funds with exposure to direct real estate are similar to hedge funds with indirect exposure with regard to reported fund characteristics.

In addition to examining differences in fund characteristics, we also contrast investment criteria across funds with varying real estate exposure. In other words, we test whether real estate exposure 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 funds with real estate exposure and zero for funds without real estate exposure. We see that funds with real estate exposure have significantly lower

**Table 11** Logistic regressions on fund characteristics

	Real estate vs. non-real estate loading indicator	NAREIT vs. NCREIF (NPI) loading indicator
Intercept	0.5070 (3.3263)	1.1284** (0.5082)
Log (Min investment)	-0.0667*** (0.0253)	-0.0817* (0.0430)
Management fee	0.1608* (0.0828)	0.0407 (0.0909)
Incentive fee	-0.0204*** (0.0068)	-0.0064 (0.0116)
High water mark	0.3836*** (0.1140)	-0.5086*** (0.1898)
Average leverage ( $\times 100$ )	-0.0009* (0.0005)	0.0042*** (0.0013)
Lockup period	0.0029 (0.0087)	-0.0033 (0.0152)
Redemption notice period	0.0022 (0.0019)	0.0072** (0.0030)
Pseudo R-square	0.0293	0.0572
N	1,702	666

This table reports the binary logistic regressions on the cross-section of measures of estimated real estate exposure. The second column models the probability of being a real estate (NAREIT or NCREIF NPI) loading fund. The third column models the probability of being a NCREIF (NPI) 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. Standard-errors of the estimated coefficients are reported in parenthesis. \*, \*\*, \*\*\* indicate significance at the 10, 5, and 1 level. The sample sizes differ due to the number of funds reporting across the characteristics of interest

minimum investment requirements, higher management fees, lower incentive fees, higher high water marks and lower leverage than funds without real estate exposure. However, we find no significant difference in redemption or lock-up periods. In column (3), we examine differences in direct (NCREIF NPI) and indirect (NAREIT) loading funds. 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 longer redemption periods (less account liquidity). Also, compared to hedge funds that have exposure to the securitized market, hedge funds that have exposure to the direct real estate market have lower minimum investment requirements, lower high water marks and higher leverage. The leverage finding is intuitive as direct investment is a channel that enables greater leverage and is not subject to margin requirements.

### Economic Value of Real Estate Exposure

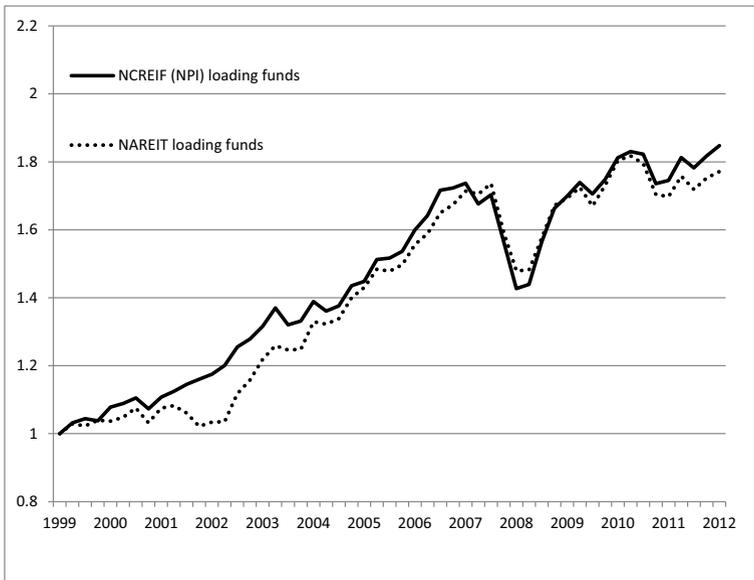
In the previous sections, we identified hedge funds that have exposure to direct or indirect real estate. Thus, in this section we turn to the question of what is the economic impact of investing across these two groups of hedge funds. To understand the economic impact, we contrast the performance of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

In each quarter starting 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 for two groups: one portfolio index representing hedge funds that have exposure to the real estate market factor; and the second portfolio index comprising funds that do not load on the real estate market factor.<sup>13</sup> 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 ( $NAREIT\_MKT_t, NPI\_MKT_t$ ).

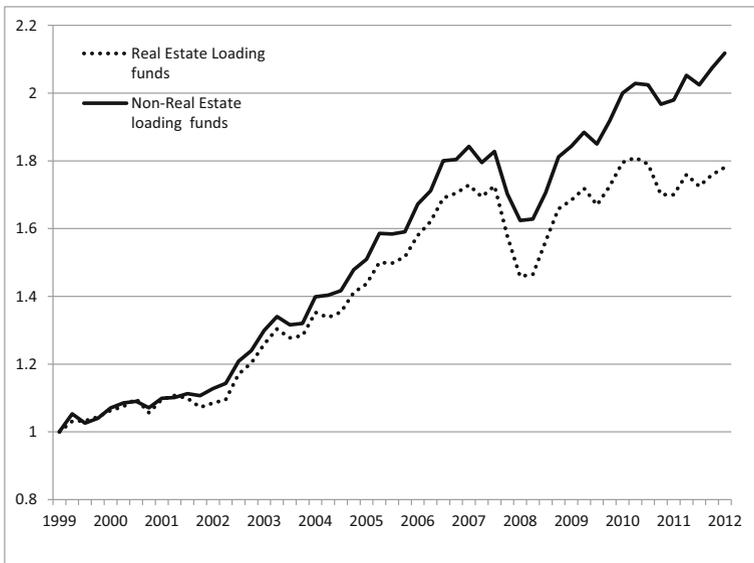
Figure 5 presents a contrast of the economic impact of funds that “track” the direct real estate market (NCREIF NPI) versus those that track the securitized market (NAREIT). Hedge funds that have exposure to direct real estate provided an annualized return of 4.75 %, whereas funds that have exposure to the securitized market provided an annualized return of 4.42 %. Up to September 2008, funds with exposure to direct real estate provided an annualized return of 5.15 %, whereas funds that had exposure to securitized real estate provided an annualized return of 5.35 %.

In Fig. 6, we contrast the economic impact of funds that “track” the real estate market (NAREIT or NCREIF NPI) against those that do not. Hedge funds that have exposure to the real estate market provide an annualized return of 4.47 %, whereas funds that do not have exposure to the real estate market generated an annualized return

<sup>13</sup> Since portfolios are adjusted to reflect funds that load and do not load on the real estate market factor, the two portfolios represent hedge funds with varying levels of exposure to the real estate market. The objective is to identify investment skill in selecting real estate exposure. Hence, we do not separate out the positive and negative coefficients of the real estate market factor as this would imply that the portfolio imposes a long or short selection criteria based on past hedge funds’ exposure to real estate.



**Fig. 5** Economic Impact of real estate hedge funds. This figure plots the cumulative returns of portfolios consisting of NCREIF NPI loading and NAREIT loading real estate hedge funds. In each quarter starting from December 1999 to December 2012, we form portfolios based on individual hedge funds’ real estate exposure, estimated from the previous 24 quarters return



**Fig. 6** Economic Impact of real estate hedge funds. This figure plots the cumulative returns of portfolios consisting of real estate loading funds (NCREIF NPI or NAREIT) versus non-real estate loading funds. In each quarter starting from December 1999 to December 2012, we form portfolios based on individual hedge funds’ real estate exposure, estimated from the previous 24 quarters return

**Table 12** Economic value of tracking the real estate market: Evidence from out-of-sample alphas: Direct versus indirect loading on real estate

	NAREIT exposure funds	NCREIF exposure funds	Spread (NAREIT - NCREIF)
Panel A: Full time period			
NAREIT vs.	0.99	0.89	0.10
NCREIF (NPI)	(1.29)	(0.93)	(0.13)
Panel B: Sub-period up to September 2008			
NAREIT vs.	1.37	0.99	0.38
NCREIF (NPI)	(1.36)	(0.72)	(0.39)

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 two portfolios based on the funds' estimated exposure to the NAREIT and NCREIF indexes 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. The sample size for Panels A and B are 52 and 35 quarters, respectively

of 5.82 %. Up to September 2008, funds with exposure to real estate earned an annualized return of 5.26 %, whereas funds that did not have exposure to real estate provided a return of 6.13 %. Overall, we infer that the return of hedge funds marginally differs with investment strategies that vary through the level of real estate exposure.

Next, 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 and 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. 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 in Table 13. We note that only non-real estate loading funds generated statistically significant positive alpha over the full time period. The real estate funds do not generate statistically significant positive alpha. Furthermore, over the sub-period that excludes the convoluting effects of the financial crisis, both real estate and non-real estate funds do not generate statistically significant alpha. In addition, when comparing the performance differential between them, we see that real estate hedge funds and non-real estate loading fund alphas are not statistically different. As a further robustness check to account for hedge funds that follow a Long/Short strategy, we test for a differential economic impact by excluding funds that have an explicit Long/Short strategy as identified in the TASS investment strategy description.<sup>14</sup> Table 14 presents the economic impact of real estate exposure across hedge funds that do not follow a

<sup>14</sup> We thank the anonymous referee for an insightful comment that Long/Short funds may be biasing our results. We present a robustness test based on a sample that excludes Long/Short funds.

**Table 13** Economic value of tracking the real estate market: evidence from out-of-sample alphas: Real estate loading versus non-real estate loading funds

	Real estate loading funds	Non real estate loading funds	Spread (loading vs non-loading)
Panel A: Full time period			
Real estate loading vs. non-real estate loading	0.82 (1.07)	2.19** (2.51)	-1.37** (-2.46)
Panel B: Sub-period up to September 2008			
Real estate loading vs. non-real estate loading	1.02 (0.93)	1.56 (1.27)	-0.54 (-0.68)

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 two 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. The sample sizes for Panels A and B are 52 and 35 quarters, respectively

Long/Short strategy. Overall, the results are unchanged from the full sample and the conclusion is that hedge fund exposure to real estate does not represent a source of managerial skill.

One concern is whether our findings are impacted by well-known biases involving dataset construction that may be present in the data. To address this concern, we note that Fung and Hsieh (2000) document that data on "fund of hedge funds" can help avoid backfill, selection, and survivorship biases. Thus, to ensure that our findings are robust we test for a differential economic impact using only a sub-sample comprising fund of hedge funds. Table 15 presents the economic impact of real estate exposure for this subset. The results are consistent with those in Table 14 and thus, the conclusion

**Table 14** Economic value of tracking the real estate market: evidence from out-of-sample alphas: Real estate loading versus non-real estate loading funds for sub-sample that excludes Long/Short hedge funds

	Real estate loading funds (less Long/Short funds)	Non real estate loading funds (less Long/Short funds)	Spread (loading vs non-loading)
Panel A: Full time period			
Real estate loading vs. non-real estate loading	0.81 (1.05)	2.33** (2.51)	-1.52** (-2.38)
Panel B: Sub-period up to September 2008			
Real estate loading vs. non-real estate loading	1.19 (1.13)	1.24 (0.96)	-0.05 (-0.07)

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 two 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. The sample sizes for Panels A and B are 52 and 35 quarters, respectively

**Table 15** Economic value of tracking the real estate market: evidence from out-of-sample alphas: Real estate loading versus non-real estate loading fund of hedge funds

	Real estate loading fund of funds	Non real estate loading fund of funds	Spread (loading vs non-loading)
Panel A: Full time period			
Real estate loading vs. non-real estate loading	-0.04 (-0.04)	1.85 (1.65)	-1.88*** (-2.93)
Panel B: Sub-period up to September 2008			
Real estate loading vs. non-real estate loading	0.28 (0.24)	0.44 (0.31)	-0.16 (-0.26)

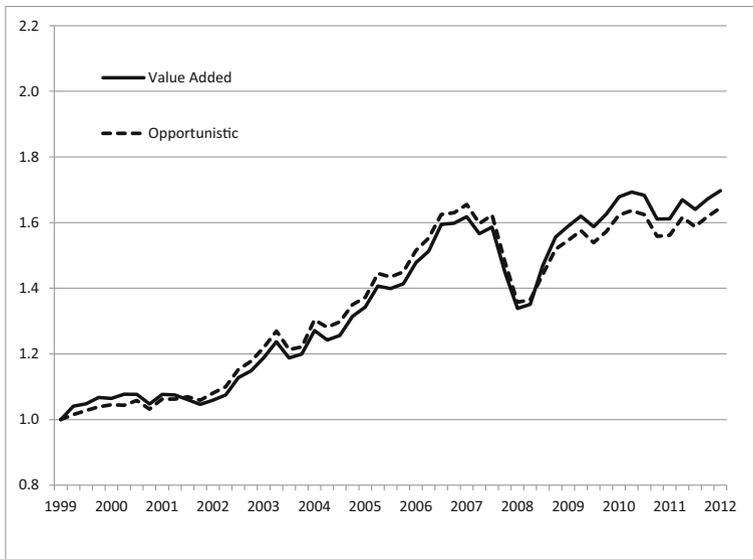
This table presents the out-of-sample alphas for the portfolios consisting of funds of hedge funds at different levels of real estate exposure. In each quarter, we form two portfolios based on the funds' estimated exposure from the past 24 quarters (i.e., ranking period) and then hold these portfolios. 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. The sample sizes for Panels A and B are 52 and 35 quarters, respectively

that hedge fund exposure to real estate does not represent a source of managerial skill remains unchanged. In conclusion, differential level of real estate exposure does not lead to a significantly different economic outcome.

### Robustness Tests

As a robustness check of our methodology of classifying funds as following a real estate strategy, we consider alternative real estate index proxies and contrast the economic impact of hedge funds that “track” the NCREIF Townsend Fund Index that represents the performance of private equity funds following an Opportunistic or Value Added investment strategy. The Opportunistic and Value Added indexes represent the returns of funds that follow a real estate strategy and have a greater risk spectrum relative to the NCREIF NPI index. We construct rolling portfolios across two groups: one portfolio representing hedge funds' returns that are explained by the real estate market factor based on the Opportunistic index and the second portfolio comprising funds that load on the real estate market factor based on the Value Added index. Following the procedure outlined earlier, we estimate the real estate market factor's coefficient for each fund using the prior 24-quarter estimation period and form two portfolios based on the significance of the real estate market factor's coefficient (5 % level) obtained through exposure to alternative index returns. Figure 7 contrasts the economic impact of funds that “track” the Opportunistic index against funds that track the Value Added index. Hedge funds that have exposure to the Opportunistic index provided an annualized return of 4.52 %, whereas funds that have exposure to the Value Added index generated a marginally lower return of 4.27 %.

Next, Table 16 reports the out-of-sample alphas for the portfolios consisting of funds that are exposed to different measures of real estate. Panel A reports the



**Fig. 7** Economic Impact of real estate hedge funds that follow a valued added or opportunistic investment strategy. This figure plots the cumulative returns of portfolios consisting of value added funds versus opportunistic hedge funds. In each quarter starting from December 1999 to December 2012, we form portfolios based on individual hedge funds' real estate exposure, estimated from the previous 24 quarters return

alphas estimated over the full sample while Panel B reports the alphas estimated for the sub-period up to September 2008. In Panel A we see that funds with exposure to the NAREIT or NCREIF NPI indexes do not have different alphas than funds that track either the Opportunistic or Value Added NCREIF Townsend Fund indexes. Furthermore, we do not find statistically significant alpha for hedge funds that have exposure to alternative measures of real estate and find no significant difference between the alphas generated by portfolios tracking the Opportunistic and Value Added indexes.

Our results are similar to those of Hartzell et al. (2010) who study the performance of real estate mutual funds. They document an increase in real estate focused funds from 27 in 1994 to 235 in 2005 and find that only 0.7 % funds earned significant positive alphas. In summary, we find strong evidence that real estate exposure does not add value to fund investors.<sup>15</sup> 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.

<sup>15</sup> Since holdings of actual real estate instruments such as mortgage backed securities and collateralized debt obligations are not available, our estimation procedure quantifies the performance of hedge funds through an estimated real estate exposure based method. The Markit ABX indexes may potentially provide an alternative identification method; however, these index returns are available from 2006 onwards and the onset of the financial crisis convolutes the estimation procedure. We also change the measure of direct real estate investment to a factor constructed from the NCREIF Transaction based index (TBI) that accounts for lagged and appraisal based issues inherent in the NCREIF NPI index and note that our results are robust to this alternative measure.

**Table 16** Economic value of tracking the real estate market: evidence from out-of-sample alphas

	Index 1 exposure funds	Index 2 exposure funds	Spread (Index 1 – Index 2)
Panel A: Full time period			
Index 1 (Value Added) vs. Index 2 (Opportunistic)	0.68 (0.64)	0.38 (0.40)	0.30 (0.64)
Index 1 (Value Added) vs. Index 2 (NAREIT)	0.68 (0.64)	0.99 (1.29)	-0.31 (-0.45)
Index 1 (Valued Added) vs. Index 2 (NCREIF (NPI))	0.68 (0.64)	0.89 (0.93)	-0.21 (-0.43)
Index 1 (Opportunistic) vs. Index 2 (NAREIT)	0.38 (0.40)	0.99 (1.29)	-0.61 (-0.89)
Index 1 (Opportunistic) vs. Index 2 (NCREIF (NPI))	0.38 (0.40)	0.89 (0.93)	-0.51 (-0.99)
Panel B: Sub-period up to September 2008			
Index 1 (Value Added) vs. Index 2 (Opportunistic)	0.36 (0.25)	0.39 (0.29)	-0.04 (-0.09)
Index 1 (Value Added) vs. Index 2 (NAREIT)	0.36 (0.25)	1.37 (1.36)	-1.01 (-1.10)
Index 1 (Valued Added) vs. Index 2 (NCREIF (NPI))	0.36 (0.25)	0.99 (0.72)	-0.63 (-1.16)
Index 1 (Opportunistic) vs. Index 2 (NAREIT)	0.39 (0.29)	1.37 (1.36)	-0.98 (-1.11)
Index 1 (Opportunistic) vs. Index 2 (NCREIF (NPI))	0.39 (0.29)	0.99 (0.72)	-0.60 (-0.98)

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. The sample size for Panels A and B are 52 and 35 quarters, respectively

## 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 1,321 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/secured 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 matched sample approach. 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 minimum investment requirements, 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 with exposure to direct real estate have lower minimum investment requirements, longer redemption periods (less account liquidity), higher leverage, and lower high water marks. 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 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. We find that real estate is not a source of hedge fund managerial skill.

## 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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