Cross Hedging Effectiveness of Real Estate Securities Exchange Traded Funds

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Abstract

We investigate the hedging effectiveness of four REIT Exchange Traded Funds in hedging seven real estate securities returns for US, Europe and Asia-Pacific through four measures of hedging effectiveness: R-Squared, hedge ratio, variance reduction and utility maximization. The study uses daily data of iShares Dow Jones U.S. REIT Index, Vanguard MSCI U.S. REIT Index, iShares FTSE EPRA/NAREIT Developed Europe Index ETF, and iShares FTSE EPRA/NAREIT Asia Index ETF. The analyses cover different full sample periods from 2000 to 2010 inclusive, the global financial crisis (GFC) period and four phases of the GFC depending on data availability to document the performances of the hedge during times of high and low volatility. The results show that the real estate ETFs were very effective in hedging EREIT and all the sampled real estate securities in Europe and Asia. Secondly, VECM hedge marginally outperformed OLS hedge when the ETFs and the real estate securities returns were cointegrated. Thirdly, we find that hedging effectiveness evidenced by variance reduction does not necessarily equate to economic viability. Therefore it is advisable to use VR and UIs together to determine viability of hedging effectiveness. Finally, given different levels of risk aversion vis-à-vis expected utility, it was, and therefore may be concluded that it could be, advisable/inadvisable to use the ETFs to hedge during periods of high/low volatility.

Keywords: Exchange Traded Fund, Real Estate Investment Trust, Equity REIT, Mortgage REIT, Real Estate Securities, Hedging Effectiveness.

Introduction

There has been an increased emergence of investable indirect real estate products such as real estate debt products, closed-end unlisted private equity real estate funds, real estate investment trust (REITs), open or closed-end real estate mutual funds, real estate hedge funds and real estate exchange traded fund (ETF) over the past one to two decades. This is due to the fact that fund managers and institutional investors have slowly begun to appreciate the role of indirect real estate securities (RES) in a mixed or concentrated portfolio (Baum, 2006). Chung et al. (2007) document that the market value of investments in US real estate securities amounted to about 170 billion US dollars as of 2004. Hedge funds alone accounted for 30 billion (17.65%) of the 170 billion US dollars of real estate securities investments as of 2004. The annual growth of hedge funds holdings in real estate securities since 2002 has been higher than that of other institutions. Furthermore the increasing emergence of real estate hedge funds which focus on real estate securities (see The

Street, 2006; REECH CBRE 2010) evidences the growing importance of the sector in portfolio management. According to Goldman Sachs Asset Management (GSAM) (2017), the market cap of US real estate securities was about US$1trillion. Assuming Hedge Funds real estate securities investment as a proportion of the market cap of US real estate securities has remained at the 2004 level of 17.65%, the market value of Hedge Funds' US real estate securities could be estimated at US$0.1765 trillion as of 2017.

The prevalence of hedge funds in the real estate securities sector may introduce with it the unique risk of gated assets. Healy & Lo (2009) report that hedge funds implemented gates during the past global financial crisis. This strategy could expose the investors' gated assets to systemic risk. Similarly, investors in traditional mutual funds are often restricted by the long only constraint on managers. According to Almazan et al. (2004), 70% of US domestic equity funds do not allow short positions. Thus, the pertinent questions that need to be addressed and which motivate this study are: how can investors whose real estate securities exposure is through long only funds add more value to their portfolio? What can investors with gated real estate securities assets do? How will investors' risk aversion level influence their hedging strategy?

Anson (2002) demonstrates how traditional long only funds have restricted portfolio requirement in the asset management industry. The restriction on going short (as a result of traditional long only funds) removes the negative alpha bets from the portfolio manager to limit the manager's ability to translate his active forecast into active weights due to limited size of the bet. Under normal circumstances, long/short managers are able to trim short positions when market is increasing to go fully short when market declines. Thus hedging or the ability to go short/long can add tremendous value to an actively managed portfolio. Moreover the devastating effects of the recent past global financial crisis (GFC) on RES markets and the implementation of gates on investors in hedge funds have highlighted the need for effective hedging instrument(s) for portfolios of real estate securities.

Earlier works (see Oppenheimer [1996], Liang et al. [1998], Chatrath & Liang [1999]) exploring suitable hedging vehicles for REITs were primarily motivated by two issues: the lack of liquid futures contract designed specifically for hedging risk associated with REITs; and the large holdings of REITs by institutions which, according to Chaudhry et al. (2010), makes compelling the analyses of suitable hedging instruments for REITs. Liang et al. [1998] conclude that REIT returns are not hedgeable by stocks, interest rates, commodities and metals' futures contracts to call for the development of futures contract specifically written on REITs. Oppenheimer (1996) finds that Treasury futures and S & P 500 index futures contracts can reduce the risk of a synthetic REIT portfolio. Similarly Bertus et al. (2008) provide evidence to show the effectiveness of CME futures in hedging house price risk in Las Vegas. Although Ong and Ng (2009) documented the proliferation of real estate derivatives and the issues surrounding their growth and development, there is no hint in the paper about any study that had successfully found a REIT hedging instrument. This could be due to the fact that the study mainly focuses on the challenges for developing real estate derivative market for Singapore especially in relation to constructing an acceptable real estate index given the thinness of the sales market among other things. Similarly Chaudhry et al (2010) affirm the lack of REIT-specific futures for hedging REITs, most probably, for being oblivious of the introduction of the Listed Property Trust Index futures on the Australian Securities Exchange in 2002. Whatever be the reason for this lapse by Ong and Ng (2009) and Chaudhury et al. (2010) the launch of Listed Property Trust Index futures on the Australian Securities Exchange in 2002 heralded the introduction of RES index futures on other Exchanges to pave way for researchers to investigate the effectiveness of REIT futures contracts in hedging REITs' returns.

Newell and Tan (2004) and Newell (2010) conclude that Australia LPT futures can effectively hedge Australia LPT portfolio returns. Lee and Lee (2012) replicate the above finding for Australia and Japan REITs. They find that Australian and Japanese REIT futures reduced the risk of the respective underlying assets by 37% to 78% and 34% to 52% over the 2002 to 2010 period. Similarly Lee et al. (2014) conclude that European RES futures contracts are effective hedging instruments (with a variance reduction of 64%) for the underlying assets. Furthermore Zhou (2016) corroborates the effectiveness of REIT futures contracts by documenting their efficacy in hedging REITs in Australia, Europe, Japan and Australia (see also Zhou, 2017; and Clements et al., 2017). It is somewhat surprising that another offshoot of the REIT Index, REIT ETF, which appeared on the US market in 2000, two years before the advent of the first REIT index futures in 2002 in Australia, has not caught the attention of researchers on hedging REIT investment. According to data extracted from Datastream on 22 October 2018, there are currently 59 equity REIT ETFs classified into 52 Active and 7 Dead in contrast to 182 REIT futures. The REIT ETFS sell on the following markets: US (24), Canada (10), Japan (13), Singapore (5), United Kingdom (3), Australia (2), South Africa (1) and South Korea (1). Furthermore seven ETFs under the US market are denominated in Euros with six trading on the Berlin Exchange and one trading on the Hamburg Exchange. The remaining ETFs under the US market predominantly trade on the NYSE Arca with only three trading on NASDAQ and one on the BATS Exchange. The ETFs under the remaining markets are denominated in their respective local currencies and traded on their respective local Exchanges.

The hedging ability of exchange traded fund (ETF) to go short/long has enabled the execution of alpha driver strategies to optimize the total alpha from both positive and negative bets without generally worrying about beta risk exposure to the market. Anson (2002) suggests that the growth of ETF, specifically real estate ETF, has brought new source of alternative beta. However the nearest study that so far relates ETF to REIT is by Boney and Sirmans (2008) who show that the introduction of Dow Jones Real Estate ETF has resulted in a significant reduction in the intraday volatility of the underlying REITs. This led to the conclusion that ETF trading activity by Authorized Participants increases the speed of price adjustment and information efficiency to translate into decreased volatility. Similarly, Seiler and Seiler (2009) examine the characteristics of newly traded REIT ETF short shares from Proshares to conclude that REIT ETF short shares warrant inclusion in a mixed asset portfolio regardless of which direction the REIT market is headed. These two studies deal with risk and diversification aspects of REIT ETFs rather than explicitly addressing their hedging effectiveness.

Pancholi & Kunkel (2003) and Alexander & Barbosa (2007) have shown the effectiveness of ETF in hedging mutual fund returns. We posit that real estate securities ETF could be a suitable hedging instrument for investors with real estate securities exposure that is through long only funds and/or whose real estate securities are gated. Thus, the paper is aimed at verifying the cross hedging effectiveness of real estate securities ETF for investors with exposure to RES, especially those with assets that are gated during extreme market volatilities, and ascertaining the effect of risk aversion on an investor's hedging strategy.

The rest of the paper proceeds as follows. The next section is devoted to literature review which is followed by methodology and data sourcing and management. This is followed by the presentation, interpretation and discussion of the results of the data analyses. The last section is devoted to concluding remarks. The results reveal that apart from Mortgage REIT (MREIT) the real estate securities ETFs (RES ETFs) would have been very effective in hedging all the remaining sampled real estate securities over the study period. Furthermore, given different levels of risk aversion and expected utility, it would have been advisable/inadvisable to hedge during periods of high/low volatility. We make a modest contribution to the literature as well as to the academic and professional fraternity of REITs by pioneering a research on hedging REITs to demonstrate the cross hedging effectiveness of REIT ETF which may hopefully stimulate more research on the topic. In addition, we contribute to the extant literature by ascertaining the impact of a RES investor's risk aversion on his RES ETF cross hedging strategies.

Exchange Traded Fund – Definition and Benefits

Hehn *et al.* (2005) consider ETFs to be instruments in a basket of securities generally designed to track a broad stock or bond market, stock industry sector or international stock and yet trades like a single stock. The U.S Securities and Exchange Commission defines ETFs as a "type of Investment Company, whose investment objective is to achieve the same return as a particular market index". The unique combination of many of its best features presents financial opportunities for both individual and institutional investors. These benefits include: a wide array of investment strategies, buying and selling flexibility and simplicity, cost effectiveness, liquidity beyond the levels provided by futures and options, cash management, core investment, diversification, hedging, tax efficiency and transparency. Thus, most studies on ETFs focus on their specific benefits. For example, Delva (2001) find that trading flexibility, tax advantages and hedging features of ETFs may be attractive for aggressive investors (see also Mussavian and Hirsch, 2002). According to Mifre (2006) international ETFs provide a better mean for portfolio diversification than the open or closed-end funds indices. This concurs with Jares and Lavin (2004) who find profit-making potential in Japan and Hong Kong ETF trading strategies. Furthermore, Hughen (2003) demonstrates that the in-kind redemption process of ETFs facilitates effective arbitrage.

Moreover, some studies focus on the tracking performance of ETF relative to its underlying constituent assets. Chiang (1998) summarizes the main tracking error determinants to be transaction costs, fund cash flows, treatment of dividends, volatility of benchmark and index composition changes. According to Hehn *et al.* (2005) ETFs have several advantages over futures – In addition to matching the main advantage of futures, that is, ability to trade both long and short, ETFs can be used for hedging so as to preserve a portfolio return while protecting it from overall market losses. Apart from being a non-derivative investment, when considering wider arrays of ETF products such as futures and options on ETFs, there is no substitute for the latter as they form an ideal complement to existing derivatives segment (Hehn et al., 2005). Freitas and Barker (2005) compare key attributes of ETFs and index futures to conclude that holding ETFs has much lower overall cost than holding equivalent amount of futures in the US. Moreover, ETFs in Europe have a more desirable cost structure in the short term. Thus, ETFs are effective tools for risk management. For instance, the short selling of index linked ETFs can be utilized to hedge a portfolio of stocks, close-end funds or open-end mutual funds (Miffre, 2006). In addition, Pancholi and Kunkel (2003) find that ETFs on S&P 500, NASDAQ and Russell 1000 Growth are effective in hedging mutual fund returns. They use the OLS regression to obtain beta coefficients which are used as optimum hedge ratios in an ex-ante hedging strategy. They then compute hedging effectiveness based on Park and Switzer (1995) measure. Although they find that ETFs are efficient hedging instruments, their analysis does not incorporate hedge ratio from more advanced econometric models and thus, lacks the economic significance of hedging from an investor's view point.

Given that ETFs compare quite favourably to futures, coupled with the existence of 59 REIT ETFs (52 active and 7 dead) across the major Exchanges of the world as of 22nd October 2018, it is worth exploring the efficacy of REIT ETFs in hedging REIT investment returns.

Hedging Effectiveness

There is considerable evidence that hedging can be very beneficial. Perold and Schulman (1998), Eaker, Grant and Woodard (1993), Glen and Jorion (1993) and Kritzman (1993) have shown that hedged portfolios offer better return/risk ratios than unhedged portfolios. Markowitz (1959) measures hedge effectiveness as the reduction in standard deviation of portfolio returns associated with a hedge. Ederington (1979), following Working (1953, 1962), Johnson (1960) and Stein (1961) defines hedging effectiveness as the percent reduction in variability to state that the objective of a hedge is to minimize risk. Howard and D'Antonio (1984) define hedging effectiveness in terms of risk and return but, as proven by Chang and Shanker (1987), the measure used by Howard and D'Antonio (1984) produces inconsistent results. According to Ederington (1979) a hedge is effective if the R-squared of OLS regression is high. However a high R-squared by itself is not always a reliable indicator of hedging effectiveness as prices of both assets involved in the hedge typically have a unit root, which can be appropriately addressed via error correction hedging models as demonstrated by Kroner and Sultan (1993) and Miffre (2004). Although the OLS technique is sensitive to violations of the classical linear regression model, it is a relatively robust and simple technique to use (Myers and Thompson, 1989). In addition, effectiveness of a hedge can be determined by the percentage reduction in risk due to the hedge (Yang, 2001). This is the ratio of variance of the unhedged position minus the variance of the hedged position to the variance of the unhedged position. Further, following Park and Switzer (1995) and Nomikos (2000), the minimum variance strategy measure of hedging effectiveness can be computed from $Var(\Delta S_t - h_t \Delta F_t)$ where h_t is the computed hedge ratio (from the OLS, ECM, VECM and BGARCH models) between spot and futures. According to Lien (2005a, 2005b), the minimum variance strategy tends to outperform others in measuring hedging effectiveness.

Optimal Hedge Ratio

The basic concept of hedging is to combine investments in the spot market and futures market to form a hedged portfolio that will reduce fluctuations in its value. The amount of futures contract that is used to reduce these fluctuations is given by the hedge ratio. Shrestha *et al.* (2003) conclude that the main objective of hedging is to choose the optimal hedge ratio (OHR). Thus, the minimum variance hedging strategy requires the estimation of hedge ratios in order to measure hedging effectiveness. The minimum variance optimal hedge ratio (MVHR) is one which minimizes the variance of the hedged position. This hedge ratio estimation can be based on an advanced econometric model with time varying hedge ratio, which has been proven to perform better than a constant hedge. Chan and Young (2006) conclude that GARCH hedge performs better than the constant hedge in the copper market. Bhattacharya *et al.* (2006) show that the cointegration GARCH model is substantially better than the standard regression-based model at hedging various mortgage backed securities (MBS) with ten-year Treasury notes futures contract. Lai *et al.* (2006) use a GARCH model to estimate optimal hedge ratios in the Hong Kong, Japan, Korea, Singapore and Taiwan indexes to conclude that their model improves on traditional OLS in three of the five markets. The MVHR derived by Johnson (1960) is easy to understand and interpret. However, it ignores the expected return on the hedged portfolio and the opportunity cost involved in hedging for the investor. Thus an additional measure is the utility maximizing hedge ratio (UMHR). This is an optimal hedge ratio that estimates the amount of futures contract to be hedged so as to maximize the utility of a risk averse investor (Shrestha *et al.,* 2003). In addition, we explore utility maximization so as to map out the economic benefits of hedging for an investor.

Methodology

Four hedging measures, R-squared (R^2), hedge ratio, variance reduction, and utility maximization are used to evaluate the effectiveness of RES ETFs in hedging real estate securities portfolio returns.

R-Squared

Ederington (1979) shows that a hedge is effective if the R^2 of the OLS regression line explaining the data (Eq. 1) is high (i.e. between 80% and 99%):

$$R_{REIT_t} = c + \beta R_{ETF_t} + \mu_t \tag{1}$$

Where

R_{ETF_t} = Return on the respective RES ETF: iShares Dow Jones U.S REIT Index ETF (IYR), Vanguard MSCI U.S REIT Index ETF (VNQ), iShares FTSE EPRA/NAREIT Developed Europe Index ETF (IFEU), iShares FTSE EPRA/NAREIT Asia Index ETF (IFAS);
R_{REIT_t} = The respective REIT Index - National Association of Real Estate Investment Trusts (NAREIT) Equity REIT (EREIT) and Mortgage REIT (MREIT) Indexes, the Dow Jones US Real Estate Operating Index (REOI); and European Public Real Estate Association (EPRA) and NAREIT (EPRA/NAREIT) data comprising: Dow Jones Europe Real Estate Securities Index (DJERESI), Dow Jones Europe REIT Index (DJEREITI), Dow Jones Asia/Pacific Real Estate Securities Index (DJAPRESI) and Dow Jones Asia/Pacific REIT Index (DJAPREITI);
μ_t = Error term;
β = Slope coefficient for the risk minimizing hedge.

Although Ederington (1979) does not substantiate the claim that a high R^2 implies hedging effectiveness, Patel (1994) demonstrates that a perfect hedge is achieved when the price of the asset being hedged is perfectly correlated with the hedge instrument. This results from the fact that a perfect correlation minimizes cross-hedge basis risk to enhance hedging effectiveness (Patel [1994]). Notwithstanding that a perfect correlation between a real estate securities portfolio and real estate securities ETF is a rarity, if achievable at all, the implication of Patel's [1994] study is that hedging effectiveness is directly related to the R^2. This is corroborated by Oppenheimer (1996:42) that "assets with corresponding futures contracts that show a significant positive or negative correlation with REIT returns represent the best securities for hedging a REIT portfolio…The greater the correlation (positive or negative) between the futures contract and

REITs, the better the hedge." Bertus et al. (2008) and Lee and Lee (2012) used the R^2 as a measure of hedge effectiveness in their studies.

Daily return for the NAREIT and REIT ETF indexes are computed as:

$$R_t = \lg(P_{t+1}) - \lg(P_t) \qquad (2)$$

The traditional approach of using regression analysis is inappropriate as it presumes that the time series are stationary. The log level difference of RES and ETF prices (not reported but obtainable from the authors) is non-stationary. Thus regressing the variables to estimate an OLS equation in levels would lead to spurious regression results as it would violate the assumption of the linear regression model that the series are stationary. However these series become stationary after the first level difference. Thus the difference of log prices is the return, R_t, in Eq. (2).

Variance Reduction

According to Park and Switzer (1995) and Kavussanos and Nomikos (2000) hedging effectiveness can be defined as the percentage of risk reduced by the hedge. The hedging effectiveness or variance reduction introduced by Ederington (1979) is given by the ratio of the difference between the variance (σ^2) of the unhedged and the hedged positions to the variance of unhedged position in Eq 3:

$$Variance\ Reduction = \frac{\sigma^2(Unhedged) - \sigma^2(Hedged)}{\sigma^2(Unhedged)} \qquad (3)$$

Further, following Park and Switzer [1995] and Kavussanos and Nomikos (2000), the minimum variance strategy measure of hedging effectiveness can be obtained from calculating $Var(\Delta S_t - h_t \Delta F_t)$, where h_t is the computed hedge ratio (based on OLS, ECM, VECM and BGARCH models) between spot and futures prices.

Hedge Ratio

The basic concept of hedging is to combine investments in the spot and futures markets to form a hedged portfolio that reduces fluctuations in the value of the portfolio. The amount of futures contract used to reduce these fluctuations is denoted by the hedge ratio. Shrestha *et al.* [2003] conclude that the main objective of hedging is to choose the optimal hedge ratio (OHR). Thus, the minimum variance hedging strategy requires the estimation of hedge ratios, the minimum variance optimal hedge ratio (MVHR), in order to measure hedging effectiveness.

According to Cecchetti (1988) and Baillie & Myers (1991), a hedger trying to hedge RES returns will do so by taking a long (short) position in the RES and short (long) the ETF with a magnitude given by h^*. Thus, the gain made by a hedger is given by equation (5).

$$R_{unhedged} = \lg\left(P_{REIT_{t+1}}\right) - \lg\left(P_{REIT_t}\right) \tag{4}$$

$$R_{hedged} = R_{unhedged} - h^*\left[\lg\left(P_{ETF_{t+1}}\right) - \lg\left(P_{ETF_t}\right)\right] \tag{5}$$

where h^* is the minimum variance hedge ratio (MVHR) while the unhedged return is the difference in logarithms of RES prices at time *t*. The MVHRs are calculated from OLS and VECM. VECM is employed only where cointegration exists between the ETF-RES pairs. **T**he residual error terms (Eq. [9]) are used to compute the hedge ratios in such cases. Restrictions are imposed on the coefficients of the RES variable in the cointegrating equation by setting these parameters to zero so as to investigate the desired effect between the RES and its hedging vehicle. Hence we have,

$$Variance\ Reduction = \frac{\sigma^2(Unhedged) - \sigma^2(OLS\ or\ VECM)}{\sigma^2(Unhedged)} \tag{6}$$

The OLS hedge ratio is estimated from OLS regression, Eq. 7).

$$R_{REIT_t} = c + h^* R_{ETF_t} + \mu_t \tag{7}$$

Although hedging instruments can be selected on the basis of correlation of returns, Alexander [2001] demonstrated that correlation is intrinsically a short run measure. Hence, correlation based hedging strategies require frequent re-balancing to account for common long-term trend in prices. This implies that there is the need to employ an Error Correction Model (ECM) to capture both short and long run characteristics of non-stationary time series which are cointegrated (Harris [1995]). Hence, an error correction term should be included in Eq. (7) to capture any short-term deviation between the assets. A bivariate vector error correction model (VECM) of Eq. (7) is also used to estimate h^{*}.

$$\Delta X_t = \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \prod X_{t-1} + \varepsilon_t \tag{8}$$

where X_t is a (2×1) vector (P_{REIT_t}, P_{ETF_t}) of non stationary *I* (1) log REIT and ETF prices, Δ denotes first difference operator and ε_t is a (2×1) vector of regression equation error terms $(\varepsilon_{REIT,t}, \varepsilon_{ETF,t})$. Once presence of cointegration is verified, the VECM model of equation (7) can be estimated by including lagged error correction term X_{t-1}. Following Kavussanos and Visvikis (2008), the VECM estimation of $h^{*}$is given by:

$$h^{*} = \frac{Cov(\varepsilon_{REIT,t}, \varepsilon_{ETF,t})}{Var(\varepsilon_{ETF,t})} \tag{9}$$

where, the error terms of both REIT and ETF are obtained from equation (8).

Utility Maximization

Ceccchetti et al. (1988) found that the optimal hedge ratio is a function of both risk-return probability and the investor's utility function as hedging involves an opportunity cost in terms of foregone consumption/returns. The minimum variance hedge ratio ignores the expected return on the hedged portfolio (Chen *et al.,* 2003). Thus in order to incorporate both risk and return in the effects of hedging, we attempt to compare the cost and benefit emanating from the reduction in risk due to the hedge. Thus the fourth measure of hedging effectiveness that accounts for economic benefits, utility increasing (UI) statistic, Equation (10) is employed. The UI compares the expected utility increase/decrease of an investor to his expected utility for the hedged and unhedged portfolios. The greater the increase in UI in relation to the unhedged portfolio, the better the hedge effectiveness:

$$UI = E_t U(R_{hedged,t}) - E_t U(R_{unhedged,t}) \tag{10}$$

where the mean-variance expected utility function is,

$$E_t U(R_{hedged,t}) = E_t(R_{ETF,t}) - kVar_t(R_{ETF,t}) \tag{11}$$

$$E_t U(R_{unhedged,t}) = E_t(R_{REIT,t}) - kVar_t(R_{REIT,t}) \tag{12}$$

where R_{ETF_t} and R_{REIT_t} are daily returns from Equation (2) and *k* is the risk aversion coefficient of an investor. Higher (lower) values of *k* imply higher (lower) levels of risk aversion.

Data Collection

The data sets used consist of daily data of the iShares Dow Jones U.S REIT Index (IYR) from 1st July 2000 to 31st Dec 2010 and the Vanguard MSCI U.S REIT Index (VNQ) from 1st Oct 2004 to 31st Dec 2010. Data for Europe and Asia-Pacific were obtained from iShares FTSE EPRA/NAREIT Developed Europe Index ETF (IFEU), and iShares FTSE EPRA/NAREIT Asia Index ETF (IFAS). The data for both Europe and Asia span a three-year period from January 2008 to December 2010. According to the iShares factsheet on IYR, the IYR ETF measures the performance of the Real Estate industry of the U.S equity market, which includes Real Estate Operating Companies (REOCs) and Real Estate Investment Trusts (REITs) subsectors. The fund generally invests at least 90% of its assets in the securities of the underlying index and in depository receipts representing the underlying index. The remainder may be invested in other stocks, money markets, swaps, options and futures if they help the fund to closely mirror the underlying index. Similarly, the factsheet on VNQ shows that VNQ ETF provides broad exposure to U.S. companies within the equity REIT sector as it invests approximately 98% of its assets in stocks of equity REITs and the remainder in cash investments. IFEU offers exposure to "companies engaged in the ownership and development of the developed Europe real estate markets". It invests 90% of its assets in the component securities of the underlying assets and in investments that have economic characteristics that are substantially identical to the component securities of the underlining index. The remainder may be invested in other stocks, money markets, swaps, options and futures if they help the fund to closely mirror the underlying index. In a similar way, IFAS "measures the performance of companies engaged in the ownership and development of the Asian real estate market". All the above ETFs share the same commonalities: they are based on equity REIT (EREIT) indexes and they are structured to replicate the respective underlying indexes.

In addition, REIT industry benchmarks constituting the NAREIT Equity REIT (EREIT) and Mortgage REIT (MREIT) Indexes, the Dow Jones US Real Estate Operating Index (REOI), and EPRA/NAREIT are employed for the study. These EPRA/NAREIT data comprise Dow Jones Europe Real Estate Securities Index (DJERESI), Dow Jones Europe REIT Index (DJEREITI), Dow Jones Asia/Pacific Real Estate Securities Index (DJAPRESI) and Dow Jones Asia/Pacific REIT Index (DJAPREITI). Hybrid REIT is excluded from the study as NAREIT has stopped publishing data on it since the end of 2010.

The REIT exchange traded funds and NAREIT indexes are chosen on the basis of several criteria. First, the daily returns for VNQ and IYR are the longest listed REITs ETF and cover about two thirds of the value of publicly traded REIT ETFs. Second, daily returns are used because Figlewski

(1986) notes that the empirical evaluation of hedging performance using daily data has tremendous value to managers and short term investors who may adjust their portfolio as often as daily. Third, the daily returns for the NAREIT indices are restricted by the availability of prices for VNQ and IYR. The data were therefore extracted from DataStream.

The analyses cover the sample periods commencing from the inception of each of the four ETFs used for the study to 2010, the global financial crisis (GFC) period, four phases of the GFC period and Pre-GFC period (see Tables 1a & 1b). Similarly, analyses for Europe and Asia cover a three-year sample period (virtually the GFC period) for the ETFs and the four phases of the GFC period. According to the National Bureau of Economic Research, the recent past GFC was from September 2007 to June 2009. The four phases of the GFC and the Pre-GFC periods are analyzed in an attempt to ascertain the hedging performances of the ETFs in periods of relatively low and different levels of relatively high market volatility. The end of the study period was intentionally set at 2010 to synchronize with the objective of the paper which is to verify the cross hedging effectiveness of real estate securities ETF for investors with exposure to real estate securities, especially those with assets that are likely to be gated in extreme market volatilities, and ascertain the effect of risk aversion on an investor's hedging strategy. There is no better period in the modern era for testing the effectiveness of a hedging instrument than the devastating recent past GFC period (when some assets were gated) which is covered by the study. Moreover, the study period provides avenues for testing the efficaciousness of the REIT ETFs as hedging instruments over periods of relatively low and different levels of relatively high market volatility to address investors questions about hedging in all conceivable different market volatility conditions – the period after 2010 would fall under some of the market volatilities that will be analysed and discussed in the study and thus may not add much significant value to the paper by analyzing it. If robust results could be found from analyses of the ETF data for the study period which encompasses all conceivable market volatilities including the most inclement market conditions (the GFC period) in recent memory, it could be argued that the ETF hedging effectiveness results could apply to post-2010 era. Any interested party may investigate the period after 2010 to keep alive the research on the cross-hedging effectiveness of REIT ETFs for the benefit of all stakeholders.

Table 1a: Sample Periods

We present the sample periods and phases of the global financial crisis (GFC) for the study. The dates for the GFC and phases thereof were extracted from NBER and BIS, 2010

Sample Period	Time Period

	VNQ	IYR	IFEU & IFAS
Full Period	Oct 2004 to Dec 2010	Jul 2000 to Dec 2010	Jan 08 to Dec 2010
GFC Period	Sep 2007 to Jun 2009		
GFC Phase 1	Sep 2007 to Aug 2008		Not Analyzed (Period too short compared to VNQ/IYR
GFC Phase 2	Sep 2008 to Dec 2008		
GFC Phase 3	Jan 2009 to Mar 2009		
GFC Phase 4	Apr 2009 to Jun 2009		
Pre-GFC	Jan 2006 to Dec 2006		N.A. (Data availability)

Table1b: GFC Timeline

We provide a brief summary (extracted from BIS, 2010) of market conditions for the Pre-GFC and GFC phases.

GFC Timeline	Time Period	World Economic Conditions
Pre-crisis Period	Before Sep 2007	Extended period of loose monetary policy, credit expansion and asset price booms – Period of low volatility. Calm before the storm (market meltdown)
Phase 1	Sep 2007 to Aug 2008	BNP funds suspended; aggressive policy easing; high commodity prices; liquidity support – Increased volatility.
Phase 2	Sep 2008 to Dec 2008	Lehman Brothers bankruptcy; global finance freezes; expanded liquidity support from governments. Financial markets in tailspin – Heightened volatility.
Phase 3	Jan 2009 to Mar 2009	Strong market interventions; synchronized G7 recession; fiscal stimulus.
Phase 4	Apr 2009 to Jun 2009	Steps to strengthen bank balance sheets by governments; financial markets rally; G3 real activity still weak.

Figures 1a and 1b show the log price trend for VNQ, IYR and REITs. The trend for Europe and Asia/Pacific (which are similar and are thus not reported) are obtainable from the authors. The market decline in 2007 marks the onset of the financial crisis which continued through June 2009. The uptrend of the market after 2009 is a sign of market recovery which was both chequered and sluggish.

Figure 1a: VNQ Log Price, Oct 2004 to Dec 2010

We report in the graphs below the log price trend of REIT ETFs, EREIT and MREIT

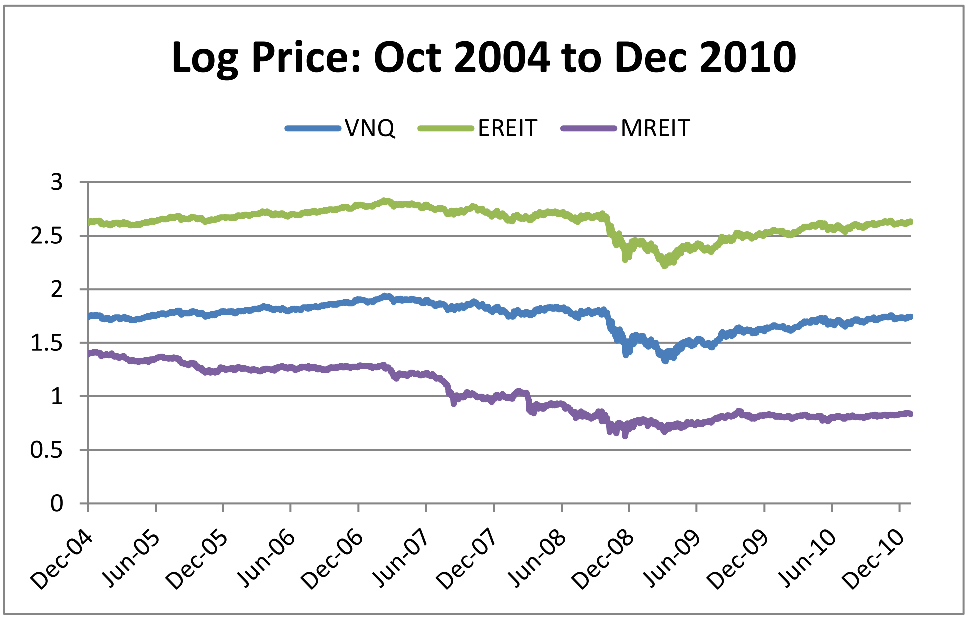
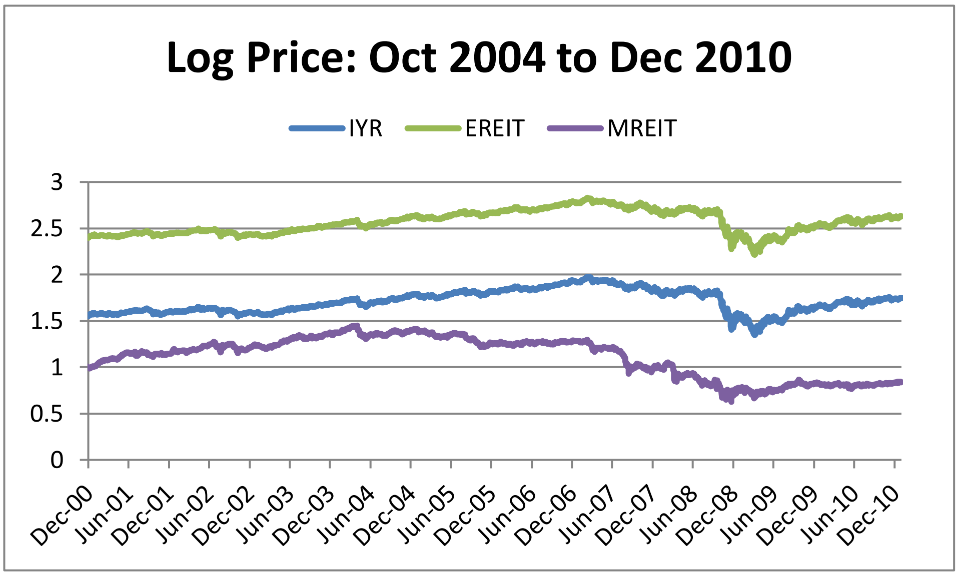


Figure 1b: IYR Log Price, Jul 2000 to Dec 2010



Results: *R-Squared Analyses*

The OLS regression R^2 for both VNQ (96.811%/85.841%) and IYR (95.070%/85.910%) presented in Table 2 indicate their effectiveness in hedging the EREIT/REOI over the in-sample period. This is attested by Ederington [1979] who concludes that a hedge is effective if R^2 is anywhere between 80% and 99%. Furthermore Patel [1994] provides evidence to show that hedging effectiveness is directly related to the R^2. The R^2 for VNQ and IYR suggest that VNQ will be more effective than IYR in hedging EREIT returns. Furthermore the R^2 for IFEU (97.115% and 97.201%) and IFAS (98.768% and 98.786%) presage their effectiveness in hedging their respective RES (Table 2). Conversely, the R^2 for both VNQ and IYR in relation to MREIT (53% and 55.801% - Table 2) signify that both ETFs will not be very effective hedges for MREIT. This may be due to the fact that VNQ and IYR are structured to replicate the performances of their respective underlying REIT Indexes – EREIT. They are meant to, and do, mirror EREIT Indexes rather than MREIT Indexes. This may imply that an MREIT ETF could be the answer for effectively hedging MREIT. Furthermore the results imply that the underlying indexes of both VNQ and IYR (EREIT) are weakly correlated to MREIT. This concurs with Hansz et al. (2017) who find the average correlation between EREIT and MREIT from 1986:02 to 2014:02 to be 0.5787. The implications of this will not be pursued further as they are tangential to the main focus of the paper. For a better analysis of the effect of each hedge on the volatility of a hedged real estate securities portfolio, we provide a more comprehensive and rigorous measures of hedging performance through the hedge ratio, variance reduction and utility maximization.

Table 2: R^2 Results

We report below the R^2 for the various real estate securities ETFs and their corresponding real estate securities.

ETF	**Real Estate Security**						
	EREIT	**MREIT**	**REOI**	**DJEREITI**	**DJERESI**	**DJAPREITI**	**DJAPRESI**
VNQ	96.811%	53%	85.841%	N/A	N/A	N/A	N/A
IYR	95.070%	55.801%	85.910%	N/A	N/A	N/A	N/A
IFEU	N/A	N/A	N/A	97.201%	97.115%	N/A	N/A
IFAS	N/A	N/A	N/A	N/A	N/A	98.786%	98.768%

Note: VNQ = Vanguard MSCI U.S REIT Index
IYR = iShares Dow Jones U.S REIT Index
IFEU = iShares FTSE EPRA/NAREIT Developed Europe Index ETF
IFAS = iShares FTSE EPRA/NAREIT Asia Index ETF
EREIT = Equity REIT
MREIT = Mortgage REIT

REOI = Real Estate Operating Index
DJEREITI = Dow Jones Europe REIT Index
DJERESI = Dow Jones Europe Real Estate Securities Index
DJAPRESI = Dow Jones Asia/Pacific Real Estate Securities Index
DJAPREITI = Dow Jones Asia/Pacific REIT Index

Hedge Ratio and Variance Reduction

The MVHRs for the VNQ_EREIT pair for the full/GFC periods are 1.011/0.933 (OLS) and 0.997/1.035 (VECM) respectively while the MVHR for the Pre-GFC period is 0.933 (OLS) (see Table 3a). These ratios are quite close to 1 to imply that the risk reduction from the OLS and VECM strategies will not be much different from the naïve hedge – Indeed the variance (risk) reduction for all three strategies is about 97% (Panels A and B of Table 3a) and 94% (Panel C of Table 3a). Furthermore the variance (0.000% and 0.001% in Panels A and B of Table 3a) imply that the OLS and VECM hedge ratios did not change much over time. This is evidenced by the hedge ratio statistics in Table 4a. The IYR_EREIT pairs provide similar results to the VNQ-EREIT (Table 3b).

The VNQ_MREIT and IYR_MREIT pair hedge ratios are remarkably different from their VNQ/IYR_EREIT counterparts (compare FTSE NAREIT Equity REITs with FTSE NAREIT Mortgage REITs – Table 3a and 3b). The OLS VNQ_MREIT hedge ratios are 0.654, 0.901 and 0.805 (Panels A, B and C respectively of Table 3a) while those for IYR_MREIT are 0.656, 0.845 and 0.761(Panels A, B and C of Table 3b). Given the relatively wide differences between the naïve and OLS hedge ratios, it is logical for the risk reduction due to both strategies to be significantly different as attested by figures under the "Variance Reduction" column of Table 3a and 3b – The OLS strategy resulted in risk reduction that ranges from approximately 50% (Panel C of Table 3a) to 57% (Panel B of Table 3b) compared to 40% (Panel A of Table 3a) to 53% (Panel C of Table 3b). Once again, readers are reminded to note from Table 3a and 3b (Panel B) and Table 4a and 4b how the OLS hedge ratios did not change much over time as implied by the relatively low variances in Panels A and B of Table 3a and 3b. Furthermore, it is worth noting that the risk reduction attendant to the ETFs verifies the earlier prognosis from the R^2 that hedge effectiveness is directly related to the R^2. For example, VNQ provides a risk reduction from 93% to 97% for EREIT (R^2 of 96.8%) compared to 40% to 56% for MREIT (R^2 of 55.8%) (Table 3a). In addition, the results corroborate the earlier finding from the R^2 analyses that the ETFs are more effective in hedging EREITs than MREITs as they are structured to mirror EREITs.

When we turn to the results for Europe and Asia, we find that the OLS hedge ratios for the full sample period are significantly higher than the naïve hedge. An investor who used IFEU to hedge DJERESI/DJEREITI had to short IFEU contracts with a notional value of approximately 2.3/2.0 to the value of these portfolios (Panel A of Table 3c). However, the OLS/VECM hedge ratios of 0.445/0.632 (Panel B of Table 3c) and 0.139/0.297 (Panel C of Table 3c) respectively are significantly lower than the naïve hedge. Moreover, the OLS and VECM strategies provide a considerably higher risk reduction for both DJERESI and DJEREITI for all the sampled periods except the GFC Phases 3 & 4 (Panel C of Table

3c) where naïve hedge provides a marginally higher risk reduction than OLS and VECM strategies. Similar results were obtained for IFAS_DJAPRESI/DJAPREITI pairs.

Table 3a: VNQ Risk-Return and Hedging Effectiveness

The reported figures are the risk and return parameters of, as well as the effectiveness of hedging EREIT and MREIT and REOI with VNQ. The highlighted are positive hedge returns relative to negative unhedged return. This implies that opportunities existed for shorting REIT ETF to earn positive returns.

	FTSE NAREIT Equity REITs						FTSE NAREIT Mortgage REITs						Dow Jones US Real Estate Operating Index					
	Hedge Ratio	Return	Variance	Expected Utility (x100)	Variance Reduction	Utility Increase (x100)	Hedge Ratio	Return	Variance	Expected Utility (x100)	Variance Reduction	Utility Increase (x100)	Hedge Ratio	Return	Variance	Expected Utility (x100)	Variance Reduction	Utility Increase (x100)
Panel A: Full Period, Oct 04 to Dec 10 (In-Sample)																		
Unhedged	0	0.003%	0.014%	-0.039	-	-	0	-0.034%	0.010%	-0.064	-	-	0	-0.002%	0.020%	-0.060	-	-
Naïve	1	0.000%	0.000%	-0.001	96.799%	0.038	1	-0.036%	0.006%	-0.054	40.082%	0.010	1	-0.001%	0.005%	-0.017	73.652%	0.044
OLS	1.011	0.000%	0.000%	-0.001	**96.811%**	0.038	0.654	-0.035%	0.004%	-0.049	**55.756%**	**0.015**	1.024	-0.001%	0.005%	-0.017	**73.693%**	**0.044**
VECM	0.997	0.000%	0.000%	-0.001	96.790%	**0.038**	-	-	-	-	-	-	-	-	-	-	-	-
Panel B: GFC Period, Sep 07 to Jun 09 (Out-Sample)																		
Unhedged	0	-0.073%	0.039%	-0.189	-	-	0	-0.048%	0.026%	-0.125	-	-	0	-0.055%	0.044%	-0.188	-	-
Naïve	1	0.000%	0.001%	-0.003	96.831%	0.186	1	0.025%	0.014%	-0.018	44.062%	**0.107**	1	-0.024%	0.010%	-0.055	**76.380%**	**0.133**
OLS	0.933	-0.004%	0.001%	-0.009	96.188%	0.180	0.901	0.018%	0.012%	-0.019	**52.227%**	0.106	0.744	-0.032%	0.013%	-0.072	69.865%	0.116
VECM	1.035	0.003%	0.001%	-0.001	**96.835%**	**0.188**	-	-	-	-	-	-	-	-	-	-	-	-
Panel C: Pre-GFC Period, Jan 06 to Dec 06 (Out-Sample)																		
Unhedged	0	0.043%	0.001%	0.039	-	-	0	0.014%	0.002%	0.008	-	-	0	0.048%	0.002%	0.042	-	-
Naïve	1	0.000%	0.000%	0.000	94.144%	-0.039	1	-0.029%	0.001%	-0.032	46.625%	-0.040	1	0.005%	0.001%	0.002	41.774%	-0.041
OLS	0.933	0.003%	0.000%	0.003	**94.451%**	**-0.036**	0.805	-0.021%	0.001%	-0.024	**50.336%**	**-0.032**	0.678	0.019%	0.001%	0.016	**46.851%**	**-0.026**
VECM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 3b: IYR Risk-Return and Hedging Effectiveness

The reported figures are the risk and return parameters of, as well as the effectiveness of hedging EREIT, MREIT and REOI with IYR. The highlighted are positive hedge returns relative to negative unhedged return. This implies that opportunities existed for shorting REIT ETF to earn positive returns.

	FTSE NAREIT Equity REITs						FTSE NAREIT Mortgage REITs						Dow Jones US Real Estate Operating Index					
	Hedge Ratio	Return	Variance	Expected Utility (x100)	Variance Reduction	Utility Increase (x100)	Hedge Ratio	Return	Variance	Expected Utility (x100)	Variance Reduction	Utility Increase (x100)	Hedge Ratio	Return	Variance	Expected Utility (x100)	Variance Reduction	Utility Increase (x100)
Panel A: Full Period, Jul 00 to Dec 10 (In-Sample)													**Full Period, Oct 04 to Dec 10 (In-Sample)**					
Unhedged	0	0.009%	0.009%	-0.018	-	-	0	-0.005%	0.007%	-0.027	-	-	0	-0.002%	0.020%	-0.060	-	-
Naïve	1	0.001%	0.000%	0.000	95.021%	**0.018**	1	-0.012%	0.004%	-0.025	41.964%	0.002	1	0.001%	0.005%	-0.015	73.598%	0.046
OLS	1.025	0.001%	0.000%	0.000	**95.078%**	0.018	0.686	-0.010%	0.003%	-0.020	**53.031%**	**0.006**	1.057	0.001%	0.005%	-0.014	**73.813%**	**0.046**
VECM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Panel B: GFC Period, Sep 07 to Jun 09 (Out-Sample)																		
Unhedged	0	-0.073%	0.039%	-0.189	-	-	0	-0.048%	0.026%	-0.125	-	-	0	-0.115%	0.052%	-0.270	-	-
Naïve	1	0.002%	0.002%	-0.003	95.853%	0.186	1	0.027%	0.013%	-0.013	47.589%	**0.112**	1	-0.039%	0.012%	-0.076	**76.170%**	**0.194**
OLS	0.900	-0.005%	0.002%	-0.012	94.178%	0.177	0.845	0.015%	0.011%	-0.017	**57.466%**	0.108	0.759	-0.057%	0.016%	-0.105	69.755%	0.166
VECM	1.031	0.005%	0.002%	0.000	**96.015%**	**0.189**	-	-	-	-	-	-	-	-	-	-	-	-
Panel C: Pre-GFC Period, Jan 06 to Dec 06 (Out-Sample)																		
Unhedged	0	0.043%	0.001%	0.039	-	-	0	0.014%	0.002%	0.008	-	-	0	0.048%	0.002%	0.042	-	-
Naïve	1	-0.001%	0.000%	-0.001	94.003%	-0.040	1	-0.030%	0.001%	-0.033	52.855%	-0.041	1	0.004%	0.001%	0.001	41.534%	-0.041
OLS	0.877	0.005%	0.000%	0.005	**94.625%**	**-0.034**	0.761	-0.020%	0.001%	-0.022	**56.061%**	**-0.030**	0.663	0.019%	0.001%	0.016	**47.786%**	**-0.026**
VECM	1.025	-0.002%	0.000%	-0.002	93.469%	-0.041	-	-	-	-	-	-	-	-	-	-	-	-

Table 3c: IFEU Risk-Return and Hedging Effectiveness

The reported figures are the risk and return parameters of, as well as the effectiveness of hedging DJERESI and DJEREITI with IFEU. The highlighted are positive and higher hedge returns relative to negative and lower positive unhedged returns. This implies that opportunities existed for shorting the ETF to earn positive returns.

	Dow Jones Europe Real Estate Securities Index						Dow Jones Europe REIT Index					
	Hedge Ratio	Return	Variance	Expected Utility (x100)	Variance Reduction	Utility Increase (x100)	Hedge Ratio	Return	Variance	Expected Utility (x100)	Variance Reduction	Utility Increase (x100)
Panel A: Full Period, Jan 08 to Dec 10 (In-Sample)												
Unhedged	0	-0.485%	1.747%	-5.725	-	-	0	-0.404%	1.214%	-4.046	-	-
Naïve	1	-0.272%	0.641%	-2.196	62.084%	3.348	1	-0.191%	0.341%	-1.215	79.823%	4.329
OLS	2.344	0.013%	0.099%	-0.285	**94.125%**	**5.259**	1.956	0.012%	0.067%	-0.189	**96.036%**	**5.354**
VECM	-	-	-	-	-	-	-	-	-	-	-	-
Panel B: GFC Phase 2, Sep 08 to Dec 08 (Out-Sample)												
Unhedged	0	-0.286%	1.691%	-5.358	-	-	0	-0.252%	0.023%	-0.321	-	-
Naïve	1	-0.011%	0.585%	-1.765	65.421%	3.778	1	0.022%	0.112%	-0.313	93.383%	5.230
OLS	0.445	-0.164%	0.041%	-0.288	**97.552%**	5.255	0.464	-0.125%	0.037%	-0.236	**97.799%**	**5.307**
VECM	0.632	-0.112%	0.001%	-0.116	96.835%	**5.427**	0.632	-0.078%	0.054%	-0.240	96.811%	5.303
Panel C: GFC Phase 3 & 4, Jan 09 to Jun 09 (Out-Sample)												
Unhedged	0	0.020%	1.727%	-5.161	-	-	0	0.013%	1.717%	-5.138	-	-
Naïve	1	0.021%	0.011%	-0.011	**99.363%**	**5.532**	1	0.013%	0.012%	-0.022	**99.301%**	**5.521**
OLS	0.139	0.021%	0.016%	-0.028	99.035%	5.515	0.158	0.013%	0.018%	-0.040	98.964%	5.503
VECM	0.297	0.021%	0.013%	-0.020	96.835%	5.524	0.293	0.013%	0.015%	-0.032	99.114%	5.511

It is worth noting that IFAS is particularly effective in hedging both DJAPRESI and DJAPREITI. It resulted in approximately 98% risk reduction for DJAPRESI for all periods and from 98% to 99.6% risk reduction for DJAPREITI (Table 3d). IFEU provided similar remarkable results, with the OLS strategy reducing risk between 94% and 99% for DJERESI and 96% to 99% for DJEREITI (Table 3c). In addition, OLS strategy predominantly outperformed VECM strategy in Table 4c. Another noteworthy finding is that over the full sample period, a hedger using both IFAS and IFEU could have reduced risk to virtually nothing while receiving positive returns (highlighted) and increased utility (Panel A of both Tables 3c and 3d). This implies that an investor could build a portfolio of IFEU and DJERESI, and IFEU and DJEREITI to reduce portfolio risk and enhance portfolio return. In the same way, one could build a portfolio with IFAS and DJAPRESI, and IFAS and DJAPREITI to achieve similar results. In other words, IFAS and IFEU have both hedging and diversification potential.

It must be noted that overall the RES ETFs are more effective in hedging EREIT and its equivalence than REOI and especially MREIT. The plausible reason for this could be that sampling strategies are used to create the various RES ETFs to replicate the underlying indexes which are virtually EREIT indexes. Thus the RES ETF indexes mirror their corresponding EREIT indexes. The two indexes almost move in lockstep to ensure high correlation (a condition for effective hedging) between them as evidenced by the R^2 results. Given the relatively weak correlation between EREIT and MREIT (Hansz et al. [2017]), an instrument that replicates EREIT is bound to have a weak correlation with MREIT and thus be less effective in hedging MREIT as evidenced by the results of the study.

Table 3d: IFAS Risk-Return and Hedging Effectiveness

The reported figures are the risk and return parameters of, as well as the effectiveness of hedging DJAPRESI and DJAPEREITI with IFAS. The highlighted are positive and higher hedged returns relative to negative unhedged returns. This implies that opportunities existed for shorting the ETF to earn positive returns.

	Dow Jones Asia/Pacific Real Estate Securities Index						Dow Jones Asia/Pacific REIT Index					
	Hedge Ratio	Return	Variance	Expected Utility (x100)	Variance Reduction	Utility Increase (x100)	Hedge Ratio	Return	Variance	Expected Utility (x100)	Variance Reduction	Utility Increase (x100)
Panel A: Full Period, Jan 08 to Dec 10 (In-Sample)												
Unhedged	0	-0.471%	1.691%	-5.543	-	-	0	-0.405%	1.220%	-4.066	-	-
Naïve	1	-0.260%	0.585%	-2.014	65.421%	3.530	1	-0.194%	0.325%	-1.170	80.752%	4.373
OLS	2.347	0.025%	0.041%	-0.099	**97.552%**	**5.444**	1.994	0.016%	0.029%	-0.072	**98.258%**	**5.471**
VECM	-	-	-	-	-	-	-	-	-	-	-	-
Panel B: GFC Phase 2, Sep 08 to Dec 08 (Out-Sample)												
Unhedged	0	-0.196%	1.691%	-5.268	-	-	0	-0.224%	0.030%	-0.315	-	-
Naïve	1	0.016%	0.585%	-1.738	65.421%	3.805	1	-0.012%	0.028%	-0.095	98.355%	**5.448**
OLS	0.620	-0.065%	0.041%	-0.189	**97.552%**	**5.355**	0.585	-0.100%	0.021%	-0.162	**98.779%**	5.382
VECM	-	-	-	-	-	-	-	-	-	-	-	-
Panel C: GFC Phase 3 & 4, Jan 09 to Jun 09 (Out-Sample)												
Unhedged	0	0.045%	1.691%	-5.028	-	-	0	0.015%	0.008%	-0.009	-	-
Naïve	1	-0.026%	0.585%	-1.780	65.421%	3.763	1	-0.055%	0.013%	-0.094	99.237%	5.449
OLS	0.529	0.007%	0.041%	-0.117	**97.552%**	**5.426**	0.552	-0.024%	0.007%	-0.043	**99.606%**	**5.500**
VECM	-	-	-	-	-	-	-	-	-	-	-	-

Variance Reduction and Utility Maximization Results

This section investigates the economic benefit of hedging beyond risk reduction and R^2. The utility maximization results in Table 3a to 3d are based on an investor with a risk aversion coefficient of (k=3). We used Eq. (11) and Eq. (12) to compute the expected utility while Eq. (10) was employed in calculating the utility increase. The risk aversion coefficient value of k=3 is in consonance with most empirical studies (see Kavussanos and Visvikis, 2008).

The variance reduction and UI statistics presented in Panels A and B of Tables 3a to 3d indicate that hedging every type of real estate security returns during the period would have been economically beneficial for investors. Panel A of Tables 3a and 3b show that although variance reduction was achieved at a cost (cost of the hedge plus, sometimes, reduction in portfolio return), the UI statistics imply that the benefits of hedging outweighed its cost to make hedging economically viable. Moreover, figures in Panel B of Tables 3a and 3b and Panel C of Table 3d reveal that positive higher returns were associated with variance reduction and positive UIs. Furthermore, whenever VECM hedge is not possible, the UIs often favor naïve/OLS hedge for EREIT/MREIT (Panels A & B of Tables 3a & 3b). However, the UIs for the US data (Tables 3a & 3b) generally favor the VECM hedge where the ETF-RES returns are cointegrated. Another conclusion to be drawn from Panel C of Tables 3a and 3b is that hedging with both VNQ and IYR was not economically beneficial as depicted by negative UIs during the Pre-GFC period although hedging would have proven effective by the variance reduction metric. This implies that if variance reduction is the sole purpose of hedging, investors may use the ETFs to hedge EREIT in low volatility market conditions otherwise it would be economically prudent to desist from hedging with the ETFs during such market conditions.

Robustness Check

According to Lien [2005a, 2005b], the best in-sample strategy does not necessarily produce the best out-of-sample hedging performance. This leads us to a discussion on the performance of the real estate ETF hedging instruments during the GFC phases (Table 1). The results presented in Tables 4a and 4b, which are somewhat similar to Panel B of Tables 3a & 3b and in Tables 3c and 3d, show that pockets of opportunities existed for shorting the RES ETFs to earn positive returns (highlighted) during different phases of the GFC. For example, VNQ_EREIT hedge would have transformed unhedged negative daily return of 0.256% to a VECM hedged positive daily return of 0.011% (about 104% increase) during GFC

Phase 2 (Panel B of Table 4a). Hedging EREIT with IYR during GFC Phase 1 (Panel A of Table 4b) would have changed unhedged negative daily return of 0.02% to VECM hedged positive daily return of 0.007% (about 135% increase). In Europe and Asia, hedging DJEREITI with IFEU and DJAPREITI with IFAS during the full period (Panel A of Tables 3c & 3d) would have yielded positive daily return of 0.012% and 0.016% respectively. These figures translate into increase in daily return (from unhedged positions) of about 103% and 104% respectively. Even where positive returns were not achieved, hedging with the ETFs yielded increased returns by significantly reducing the unhedged negative returns.

Furthermore, all the ETF hedging models result in very high variance reduction (in excess of 94%) for EREIT and all types of real estate securities in Asia and Europe; moderate to moderately-high variance reduction between 55% and 80% for REOI; and moderate variance reduction of between 45% and 69% (except Naïve hedge – Panel C of Table 4a & 4b) for MREIT. Moreover, the positive UIs for every hedging model in all panels of Tables 3c, 3d, 4a and 4b attest to the economic viability, and thus, effectiveness of the ETFs in hedging the sampled real estate securities returns during every phase of the GFC.

Sensitivity of UIs to Different Levels of Risk Aversion

Since investors exhibit varying levels of risk aversion, we investigate the UIs for different levels of risk aversion (see Tables 5a through 7b) to make the results meaningful to as much investors as possible.

Table 4a: VNQ Risk-Return and Hedging Effectiveness (GFC Phases)

The reported figures are the risk and return parameters of, as well as the effectiveness of hedging EREIT, MREIT and REOI with VNQ during the GFC phases. Phases 3 & 4 are combined as both are recovery phases. The highlighted are positive hedge returns relative to negative unhedged return. This implies that opportunities existed for shorting REIT ETF to earn positive returns.

	FTSE NAREIT Equity REITs						FTSE NAREIT Mortgage REITs						Dow Jones US Real Estate Operating Index					
	Hedge Ratio	Return	Variance	Expected Utility (x100)	Variance Reduction	Utility Increase (x100)	Hedge Ratio	Return	Variance	Expected Utility (x100)	Variance Reduction	Utility Increase (x100)	Hedge Ratio	Return	Variance	Expected Utility (x100)	Variance Reduction	Utility Increase (x100)
Panel A: GFC Phase 1, Sep 07 to Aug 08 (Out-Sample)																		
Unhedged	0	-0.020%	0.010%	-0.049	-	-	0	-0.067%	0.015%	-0.113	-	-	0	-0.012%	0.009%	-0.040	-	-
Naïve	1	0.000%	0.000%	-0.001	95.880%	0.047	1	-0.048%	0.008%	-0.072	44.993%	**0.040**	1	0.008%	0.004%	-0.004	55.427%	**0.035**
OLS	0.933	-0.001%	0.000%	-0.002	**95.901%**	0.047	0.901	-0.050%	0.008%	-0.074	**46.236%**	0.039	0.744	0.003%	0.004%	-0.008	**61.042%**	0.032
VECM	1.035	0.000%	0.000%	-0.001	95.672%	**0.048**	-	-	-	-	-	-	-	-	-	-	-	-
Panel B: GFC Phase 2, Sep 08 to Dec 08 (Out-Sample)																		
Unhedged	0	-0.256%	0.102%	-0.563	-	-	0	-0.054%	0.072%	-0.269	-	-	0	-0.607%	0.143%	-1.035	-	-
Naïve	1	0.004%	0.002%	-0.001	98.308%	0.562	1	0.206%	0.027%	0.124	62.157%	**0.394**	1	-0.348%	0.032%	-0.443	**77.907%**	**0.593**
OLS	0.959	-0.007%	0.002%	-0.013	97.909%	0.550	0.872	0.173%	0.022%	0.105	**68.874%**	0.375	0.757	-0.411%	0.041%	-0.534	71.195%	0.501
VECM	1.028	0.011%	0.002%	0.006	**98.402%**	**0.569**	-	-	-	-	-	-	0.761	-0.410%	0.041%	-0.533	71.335%	0.503
Panel C: GFC Phase 3 & 4, Jan 09 to Jun 09 (Out-Sample)																		
Unhedged	0	-0.055%	0.054%	-0.218	-	-	0	-0.006%	0.016%	-0.055	-	-	0	0.015%	0.076%	-0.212	-	-
Naïve	1	0.000%	0.003%	-0.008	95.261%	0.210	1	0.049%	0.018%	-0.005	-9.950%	0.050	1	0.069%	0.015%	0.025	80.483%	0.237
OLS	1.007	-0.003%	0.003%	-0.011	94.979%	0.207	0.779	0.037%	0.009%	0.010	**45.114%**	**0.064**	0.984	0.068%	0.015%	0.023	80.230%	0.236
VECM	1.007	0.001%	0.003%	-0.007	**95.276%**	**0.211**	-	-	-	-	-	-	1.011	0.070%	0.015%	0.026	**80.627%**	**0.238**

Table 4b: IYR Risk-Return and Hedging Effectiveness (GFC Phases)

The reported figures are the risk and return parameters, as well as the effectiveness, of hedging EREIT, MREIT and REOI with IYR during the GFC phases. Phases 3 & 4 are combined as both are recovery phases. The highlighted are positive hedge returns relative to negative unhedged return. This implies that opportunities existed for shorting REIT ETF to earn positive returns.

	FTSE NAREIT Equity REITs						FTSE NAREIT Mortgage REITs						Dow Jones US Real Estate Operating Index					
	Hedge Ratio	Return	Variance	Expected Utility (x100)	Variance Reduction	Utility Increase (x100)	Hedge Ratio	Return	Variance	Expected Utility (x100)	Variance Reduction	Utility Increase (x100)	Hedge Ratio	Return	Variance	Expected Utility (x100)	Variance Reduction	Utility Increase (x100)
Panel A: GFC Phase 1, Sep 07 to Aug 08 (Out-Sample)																		
Unhedged	0	-0.020%	0.010%	-0.049	-	-	0	-0.067%	0.015%	-0.113	-	-	0	-0.012%	0.009%	-0.040	-	-
Naïve	1	0.006%	0.000%	0.005	**96.554%**	0.054	1	-0.042%	0.007%	-0.064	50.523%	**0.049**	1	0.014%	0.004%	0.003	58.220%	**0.042**
OLS	0.900	0.004%	0.000%	0.003	96.149%	0.052	0.845	-0.046%	0.007%	-0.068	**50.531%**	0.045	0.759	0.008%	0.004%	-0.003	**62.018%**	0.037
VECM	1.031	0.007%	0.000%	0.006	96.537%	**0.054**	-	-	-	-	-	-	-	-	-	-	-	-
Panel B: GFC Phase 2, Sep 08 to Dec 08 (Out-Sample)																		
Unhedged	0	-0.256%	0.102%	-0.563	-	-	0	-0.054%	0.072%	-0.269	-	-	0	-0.607%	0.143%	-1.035	-	-
Naïve	1	0.007%	0.004%	-0.004	**96.442%**	**0.559**	1	0.209%	0.028%	0.127	61.629%	**0.396**	1	-0.345%	0.033%	-0.444	**76.680%**	**0.591**
OLS	0.946	-0.007%	0.004%	-0.020	95.732%	0.543	0.877	0.177%	0.023%	0.107	**67.570%**	0.377	0.783	-0.402%	0.042%	-0.527	70.771%	0.509
VECM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Panel C: GFC Phase 3 & 4, Jan 09 to Jun 09 (Out-Sample)																		
Unhedged	0	-0.055%	0.054%	-0.218	-	-	0	-0.006%	0.016%	-0.055	-	-	0	0.015%	0.076%	-0.212	-	-
Naïve	1	-0.008%	0.003%	-0.017	**94.828%**	**0.201**	1	0.041%	0.016%	-0.007	1.936%	0.048	1	0.061%	0.015%	0.017	80.360%	0.229
OLS	1.004	-0.011%	0.003%	-0.020	94.057%	0.197	0.798	0.031%	0.009%	0.006	**47.248%**	**0.060**	1.004	0.062%	0.015%	0.017	80.438%	0.229
VECM	-	-	-	-	-	-	-	-	-	-	-	-	1.021	0.062%	0.015%	0.019	**80.743%**	**0.231**

The results in Panels B and C of Tables 5a to 6c show that the hedged UIs are higher than their unhedged counterparts during the GFC period. This confirms the earlier finding that hedging RES returns with the RES ETFs during the GFC (Panel B of Tables 5a to 6c) – a period of heightened volatility – would have been both effective (in reducing risk) and economically viable in maximizing utility (i.e. improving returns). On the other hand, it would not have been economically profitable, as evidenced by lower and/or negative UIs, to have hedged the RES returns during the Pre-GFC (panel C of Tables 5a to 6c) – a period of relatively low volatility. The figures in Table 7a (Europe) and Table 7b (Asia/Pacific) clearly attest to the effectiveness and economic viability of hedging REITs with RES ETFs. Furthermore, the results reveal that the investor with the lowest risk aversion (k=0.1), perhaps the die-hard risk taker/speculator would have reaped maximum utility by shorting real estate ETFs to earn positive returns during the financial crisis. This could have occurred when the spot price of the ETFs were perceived to be higher than the future price or that the price of the ETFs were likely to decline (windows of opportunity) during the period under investigation. In either case, the active fund manager and/or speculator may short sell his/her ETFs at the spot price with the hope of buying back the borrowed shares at a lower price sometime later during the study period to make profit. Short selling ETFs in extreme market volatilities would appeal to the active alpha-seeking Fund Manager who wants to capitalize on REIT ETFS as hedging instruments for his RES holdings, especially equity RES. Thus the ability to short sell REIT ETFs during the "windows of opportunity" within extreme market volatilities provides an answer to the three research questions that motivated this study: how can investors whose real estate securities exposure is through long only funds add more value to their portfolio? What can investors with gated real estate securities assets do? How will investors' risk aversion level influence their hedging strategy?

The answer to the first two questions is: they can short sell. Given that hedging with RES ETFs in a period of extreme market turbulence (GFC period) was economically viable in maximizing utility (i.e. improving returns) and that the least risk-averse investor could profit most from the situation, shrewd investors and fund managers would intelligently and cautiously short sell to add value to their portfolio holdings. Certainly, shorting REIT ETFs is risky but so is every investment. Investment is about risk management not risk avoidance as the latter could amount to doing nothing. Moreover short selling could be an effective risk management tool for the informed, intelligent and prudent fund manager and/or speculator in turbulent market conditions as pertained to the period under investigation. As noted by Oppenheimer (1996:42), "positive correlation between REITS and futures contract" (RES ETF in our case) "requires a short position…" Thus, taking short positions with RES ETFs during windows of opportunity in such volatile market situations could enhance the value of investors' RES portfolio in addition to reducing risk – i.e. killing two birds with one stone.

As far as the ordinary REIT investor who wants to ensure that the value of his investment is secured through hedging, the results clearly show that the various RES ETFs are very effective in hedging the sampled equity RES in the three REIT markets: US, Europe and Asia used for the study. However, the results show that adopting a hedging strategy of the lowest risk-averse investor (answer to the third question) is much more rewarding and thus preferable if investors want to maximize expected utility through cross hedging with RES ETF (Table 5a – 7b).

Table 5a: VNQ_EREIT – Sensitivity of Expected Utility (EU) to Varying Risk Aversion (*k*)

We report in this Table the sensitivity of EU (positive highlighted) to *k*. Note that virtually all the hedged EUs in Panels A & B are higher than unhedged EUs while those in Panel C (except *k*=100) are the exact opposite. The general trend is: the lower the risk aversion, the higher the EU. Positive hedged EUs relative to negative unhedged EUs are highlighted. Note that the Positive EUs accompany positive return (Panel B).

	FTSE NAREIT Equity REITs								
	Return	Variance	Expected Utility (x100)						
			k=0.1	k=1	k=2	k=3	k=4	k=10	k=100
Panel A: Full Period, Oct 04 to Dec 10 (In-Sample)									
Unhedged	0.003%	0.014%	0.001	-0.011	-0.025	-0.039	-0.053	-0.137	-1.397
Naïve	0.000%	0.000%	0.000	0.000	-0.001	-0.001	-0.001	-0.004	-0.045
OLS	0.000%	0.000%	0.000	0.000	-0.001	-0.001	-0.002	-0.004	-0.044
VECM	0.000%	0.000%	0.000	0.000	-0.001	-0.001	-0.001	-0.004	-0.045
Panel B: GFC Period, Sep 07 to Jun 09 (Out-Sample)									
Unhedged	-0.073%	0.039%	-0.077	-0.112	-0.150	-0.189	-0.227	-0.459	-3.933
Naïve	0.000%	0.001%	0.000	-0.001	-0.002	-0.003	-0.004	-0.012	-0.122
OLS	-0.004%	0.001%	-0.005	-0.006	-0.007	-0.009	-0.010	-0.019	-0.152
VECM	0.003%	0.001%	0.003	0.002	0.001	-0.001	-0.002	-0.009	-0.119
Panel C: Pre-GFC Period, Jan 06 to Dec 06 (Out-Sample)									
Unhedged	0.043%	0.001%	0.043	0.042	0.040	0.039	0.037	0.028	-0.107
Naïve	0.000%	0.000%	0.000	0.000	0.000	0.000	0.000	-0.001	-0.008
OLS	0.003%	0.000%	0.003	0.003	0.003	0.003	0.003	0.002	-0.005
VECM	-	-	-	-	-	-	-	-	-

Table 5b: VNQ_MREIT – Sensitivity of Expected Utility (EU) to Varying Risk Aversion (*k*)

We report in this Table the sensitivity of EU (positive highlighted) to *k.* Note that virtually all the hedged EUs in Panels A & B are higher than unhedged EUs while those in Panel C (except *k*=100) are the exact opposite. The general trend is: the lower the risk aversion, the higher the EU. Positive hedged EUs relative to negative unhedged EUs are highlighted. Note that the Positive EUs accompany positive returns.

	FTSE NAREIT Mortgage REITs								
	Return	Variance	Expected Utility (x100)						
			k=0.1	k=1	k=2	k=3	k=4	k=10	k=100
Panel A: Full Period, Oct 04 to Dec 10 (In-Sample)									
Unhedged	-0.034%	0.010%	-0.035	-0.044	-0.054	-0.064	-0.074	-0.135	-1.048
Naïve	-0.036%	0.006%	-0.037	-0.042	-0.048	-0.054	-0.060	-0.097	-0.644
OLS	-0.035%	0.004%	-0.036	-0.040	-0.044	-0.049	-0.053	-0.080	-0.484
VECM	-	-	-	-	-	-	-	-	-
Panel B: GFC Period, Sep 07 to Jun 09 (Out-Sample)									
Unhedged	-0.048%	0.026%	-0.051	-0.074	-0.100	-0.125	-0.151	-0.306	-2.621
Naïve	0.025%	0.014%	0.024	0.011	-0.004	-0.018	-0.032	-0.119	-1.414
OLS	0.018%	0.012%	0.017	0.006	-0.007	-0.019	-0.031	-0.105	-1.211
VECM	-	-	-	-	-	-	-	-	-
Panel C: Pre-GFC Period, Jan 06 to Dec 06 (Out-Sample)									
Unhedged	0.014%	0.002%	0.013	0.012	0.010	0.008	0.006	-0.006	-0.181
Naïve	-0.029%	0.001%	-0.029	-0.030	-0.031	-0.032	-0.034	-0.040	-0.133
OLS	-0.021%	0.001%	-0.021	-0.022	-0.023	-0.024	-0.025	-0.031	-0.118
VECM	-	-	-	-	-	-	-	-	-

Table 5c: VNQ_REOI – Sensitivity of Expected Utility (EU) to Varying Risk Aversion (*k*)

We report in this Table the sensitivity of EU to *k*. Note that virtually all the hedged EUs in Panels A & B are higher than unhedged EUs while those in Panel C (except *k*=100) are the exact opposite. The general trend is: the lower the risk aversion, the higher the EU.

	Dow Jones US Real Estate Operating Index								
	Return	Variance	Expected Utility (x100)						
			k=0.1	k=1	k=2	k=3	k=4	k=10	k=100
Panel A: Full Period, Oct 04 to Dec 10 (In-Sample)									
Unhedged	-0.002%	0.020%	-0.004	-0.021	-0.041	-0.060	-0.080	-0.197	-1.957
Naïve	-0.001%	0.005%	-0.002	-0.006	-0.011	-0.017	-0.022	-0.053	-0.516
OLS	-0.001%	0.005%	-0.002	-0.006	-0.011	-0.017	-0.022	-0.053	-0.515
VECM	-	-	-	-	-	-	-	-	-
Panel B: GFC Period, Sep 07 to Jun 09 (Out-Sample)									
Unhedged	-0.055%	0.044%	-0.060	-0.100	-0.144	-0.188	-0.233	-0.499	-4.488
Naïve	-0.024%	0.010%	-0.025	-0.034	-0.045	-0.055	-0.066	-0.129	-1.071
OLS	-0.032%	0.013%	-0.033	-0.045	-0.059	-0.072	-0.085	-0.166	-1.368
VECM	-	-	-	-	-	-	-	-	-
Panel C: Pre-GFC Period, Jan 06 to Dec 06 (Out-Sample)									
Unhedged	0.048%	0.002%	0.048	0.046	0.044	0.042	0.041	0.029	-0.139
Naïve	0.005%	0.001%	0.005	0.004	0.003	0.002	0.001	-0.006	-0.104
OLS	0.019%	0.001%	0.019	0.018	0.017	0.016	0.015	0.009	-0.080
VECM	-	-	-	-	-	-	-	-	-

Table 6a: IYR_EREIT – Sensitivity of Expected Utility (EU) to Varying Risk Aversion (*k*)

We report in this Table the sensitivity of EU (positive highlighted) to *k*. Note that virtually all the hedged EUs in Panels A & B are higher than unhedged EUs while those in Panel C (except *k*=100) are the exact opposite. The general trend is: the lower the risk aversion, the higher the EU. Positive hedged EUs relative to negative unhedged EUs are highlighted. Note that the Positive EUs accompany positive returns (Panels A & B).

	FTSE NAREIT Equity REITs								
	Return	Variance	Expected Utility (x100)						
			k=0.1	k=1	k=2	k=3	k=4	k=10	k=100
Panel A: Full Period, Jul 00 to Dec 10 (In-Sample)									
Unhedged	0.009%	0.009%	0.008	0.000	-0.009	-0.018	-0.027	-0.080	-0.878
Naïve	0.001%	0.000%	0.001	0.001	0.000	0.000	0.000	-0.003	-0.043
OLS	0.001%	0.000%	0.001	0.001	0.000	0.000	-0.001	-0.003	-0.042
VECM	-	-	-	-	-	-	-	-	-
Panel B: GFC Period, Sep 07 to Jun 09 (Out-Sample)									
Unhedged	-0.073%	0.039%	-0.077	-0.112	-0.150	-0.189	-0.227	-0.459	-3.933
Naïve	0.002%	0.002%	0.002	0.001	-0.001	-0.003	-0.004	-0.014	-0.158
OLS	-0.005%	0.002%	-0.005	-0.007	-0.010	-0.012	-0.014	-0.028	-0.230
VECM	0.005%	0.002%	0.004	0.003	0.002	0.000	-0.002	-0.011	-0.149
Panel C: Pre-GFC Period, Jan 06 to Dec 06 (Out-Sample)									
Unhedged	0.043%	0.001%	0.043	0.042	0.040	0.039	0.037	0.028	-0.107
Naïve	-0.001%	0.000%	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.010
OLS	0.005%	0.000%	0.005	0.005	0.005	0.005	0.005	0.004	-0.003
VECM	-0.002%	0.000%	-0.002	-0.002	-0.002	-0.002	-0.002	-0.003	-0.011

Table 6b: IYR_MREIT – Sensitivity of Expected Utility (EU) to Varying Risk Aversion (*k*)

We report in this Table the sensitivity of EU (positive highlighted) to *k*. Note that all the EUs in Panel A are negative. Furthermore, unhedged EUs for k=0.1 and k=1are higher than hedged EUs, k=2 provides mixed results while the hedged EUs for k=3 to k=100 are higher than unhedged EUs albeit all EUs being negative (Panel A). In contrast, all the hedged EUs in Panel B (some being positive) are higher than unhedged EUs while those in Panel C (except *k*=100) are the exact opposite. The general trend in Panel B (a period of high volatility) is: the lower the risk aversion, the higher the EU for hedging MREIT. Based on the EUs for the entire sample period, hedging MREIT would be economically viable for investors with risk aversion > k=2 (Panel A) but only so for investors with relatively very high risk aversion (Panel C, k=100). Positive hedged EUs relative to negative unhedged EUs are highlighted. Note that the Positive EUs accompany positive returns (Panel B).

	FTSE NAREIT Mortgage REITs								
	Return	Variance	Expected Utility (x100)						
			k=0.1	k=1	k=2	k=3	k=4	k=10	k=100
Panel A: Full Period, Jul 00 to Dec 10 (In-Sample)									
Unhedged	-0.005%	0.007%	-0.006	-0.012	-0.019	-0.027	-0.034	-0.077	-0.718
Naïve	-0.012%	0.004%	-0.013	-0.017	-0.021	-0.025	-0.029	-0.054	-0.426
OLS	-0.010%	0.003%	-0.011	-0.014	-0.017	-0.020	-0.024	-0.044	-0.345
VECM	-	-	-	-	-	-	-	-	-
Panel B: GFC Period, Sep 07 to Jun 09 (Out-Sample)									
Unhedged	-0.048%	0.026%	-0.051	-0.074	-0.100	-0.125	-0.151	-0.306	-2.621
Naïve	0.027%	0.013%	0.026	0.014	0.000	-0.013	-0.027	-0.108	-1.322
OLS	0.015%	0.011%	0.014	0.004	-0.006	-0.017	-0.028	-0.094	-1.079
VECM	-	-	-	-	-	-	-	-	-
Panel C: Pre-GFC Period, Jan 06 to Dec 06 (Out-Sample)									
Unhedged	0.014%	0.002%	0.013	0.012	0.010	0.008	0.006	-0.006	-0.181
Naïve	-0.030%	0.001%	-0.030	-0.031	-0.032	-0.033	-0.034	-0.039	-0.122
OLS	-0.020%	0.001%	-0.020	-0.021	-0.021	-0.022	-0.023	-0.028	-0.105
VECM	-	-	-	-	-	-	-	-	-

Table 6c: IYR_REOI – Sensitivity of Expected Utility (EU) to Varying Risk Aversion (*k*)

We report in this Table the sensitivity of EU (positive highlighted) to *k*. Note that virtually all the hedged EUs in Panels A & B are higher than unhedged EUs while those in Panel C (except *k*=100) are the exact opposite. The general trend is: the lower the risk aversion, the higher the EU. Note that the Positive EU accompanies positive return (Panel A).

	Dow Jones US Real Estate Operating Index								
	Return	Variance	Expected Utility (x100)						
			k=0.1	k=1	k=2	k=3	k=4	k=10	k=100
Panel A: Full Period, Oct 04 to Dec 10 (In-Sample)									
Unhedged	-0.002%	0.020%	-0.004	-0.021	-0.041	-0.060	-0.080	-0.197	-1.957
Naïve	0.001%	0.005%	0.000	-0.004	-0.009	-0.015	-0.020	-0.051	-0.515
OLS	0.001%	0.005%	0.001	-0.004	-0.009	-0.014	-0.019	-0.050	-0.511
VECM	-	-	-	-	-	-	-	-	-
Panel B: GFC Period, Sep 07 to Jun 09 (Out-Sample)									
Unhedged	-0.055%	0.044%	-0.060	-0.100	-0.144	-0.188	-0.233	-0.499	-4.488
Naïve	-0.021%	0.011%	-0.022	-0.032	-0.042	-0.053	-0.064	-0.127	-1.082
OLS	-0.029%	0.014%	-0.031	-0.043	-0.057	-0.070	-0.084	-0.165	-1.382
VECM	-	-	-	-	-	-	-	-	-
Panel C: Pre-GFC Period, Jan 06 to Dec 06 (Out-Sample)									
Unhedged	0.048%	0.002%	0.048	0.046	0.044	0.042	0.041	0.029	-0.139
Naïve	0.004%	0.001%	0.004	0.003	0.002	0.001	0.000	-0.007	-0.105
OLS	0.019%	0.001%	0.019	0.018	0.017	0.016	0.015	0.009	-0.079
VECM	-	-	-	-	-	-	-	-	-

Table 7a (i): IFEU_DJERESI – Sensitivity of Expected Utility (EU) to Varying Risk Aversion (*k*)

We report in this Table the sensitivity of EU (positive highlighted) to *k*. Note that virtually all the hedged EUs in Panels A & B are higher than unhedged EUs while those in Panel C (except *k*=100) are the exact opposite. The general trend is: the lower the risk aversion, the higher the EU. Positive hedged EUs relative to negative unhedged EUs are highlighted. Note that the Positive EU accompany positive return (Panel A).

	Dow Jones Europe Real Estate Securities Index								
	Return	Variance	Expected Utility (x100)						
			k=0.1	k=1	k=2	k=3	k=4	k=10	k=100
Panel A: Full Period, Jan 08 to Dec 10 (In-Sample)									
Unhedged	-0.485%	1.747%	-0.659	-2.232	-3.978	-5.725	-7.472	-17.953	-175.169
Naïve	-0.272%	0.641%	-0.336	-0.913	-1.554	-2.196	-2.837	-6.683	-64.380
OLS	0.013%	0.099%	0.003	-0.086	-0.185	-0.285	-0.384	-0.980	-9.920
VECM	-	-	-	-	-	-	-	-	-
Panel B: GFC Phase 2, Sep 08 to Dec 08 (Out-Sample)									
Unhedged	-0.286%	0.024%	-0.288	-0.310	-0.334	-0.358	-0.382	-0.527	-2.696
Naïve	-0.011%	0.117%	-0.023	-0.129	-0.246	-0.363	-0.480	-1.182	-11.721
OLS	-0.164%	0.039%	-0.167	-0.202	-0.241	-0.280	-0.318	-0.550	-4.031
VECM	-0.112%	0.058%	-0.118	-0.170	-0.228	-0.285	-0.343	-0.689	-5.876
Panel C: GFC Phase 3 & 4, Jan 09 to Jun 09 (Out-Sample)									
Unhedged	0.020%	0.020%	0.019	0.001	-0.019	-0.038	-0.058	-0.175	-1.939
Naïve	0.021%	0.011%	0.020	0.010	0.000	-0.011	-0.022	-0.087	-1.055
OLS	0.021%	0.016%	0.019	0.004	-0.012	-0.028	-0.045	-0.143	-1.611
VECM	0.021%	0.013%	0.019	0.007	-0.006	-0.020	-0.033	-0.113	-1.320

Table 7a (ii): IFEU_DJEREITI – Sensitivity of Expected Utility (EU) to Varying Risk Aversion (*k*)

We report in this Table the sensitivity of EU (positive highlighted) to *k*. Note that virtually all the hedged EUs in Panels A & B are higher than unhedged EUs while those in Panel C (except *k*=100) are the exact opposite. The general trend is: the lower the risk aversion, the higher the EU. Positive hedged EUs relative to negative unhedged EUs are highlighted. Note that the Positive EUs accompany positive returns (Panels A & B).

	Dow Jones Europe REIT Index								
	Return	Variance	Expected Utility (x100)						
			k=0.1	k=1	k=2	k=3	k=4	k=10	k=100
Panel A: Full Period, Jan 08 to Dec 10 (In-Sample)									
Unhedged	-0.404%	1.214%	-0.525	-1.618	-2.832	-4.046	-5.261	-12.546	-121.830
Naïve	-0.191%	0.341%	-0.225	-0.532	-0.873	-1.215	-1.556	-3.603	-34.306
OLS	0.012%	0.067%	0.005	-0.055	-0.122	-0.189	-0.256	-0.658	-6.690
VECM	-	-	-	-	-	-	-	-	-
Panel B: GFC Phase 2, Sep 08 to Dec 08 (Out-Sample)									
Unhedged	-0.252%	0.023%	-0.254	-0.275	-0.298	-0.321	-0.344	-0.482	-2.551
Naïve	0.022%	0.112%	0.011	-0.089	-0.201	-0.313	-0.425	-1.096	-11.165
OLS	-0.125%	0.037%	-0.128	-0.162	-0.199	-0.236	-0.273	-0.497	-3.845
VECM	-0.078%	0.054%	-0.084	-0.132	-0.186	-0.240	-0.294	-0.618	-5.470
Panel C: GFC Phase 3 & 4, Jan 09 to Jun 09 (Out-Sample)									
Unhedged	0.013%	0.021%	0.010	-0.009	-0.030	-0.051	-0.073	-0.200	-2.116
Naïve	0.013%	0.012%	0.012	0.001	-0.011	-0.022	-0.034	-0.105	-1.169
OLS	0.013%	0.018%	0.011	-0.005	-0.022	-0.040	-0.057	-0.163	-1.740
VECM	0.013%	0.015%	0.011	-0.002	-0.017	-0.032	-0.047	-0.137	-1.486

Table 7b (i): IFAS_DJAPERESI – Sensitivity of Expected Utility (EU) to Varying Risk Aversion (*k*)

We report in this Table the sensitivity of EU (positive highlighted) to *k*. Note that virtually all the hedged EUs in Panels A & B are higher than unhedged EUs while those in Panel C are the exact opposite. The general trend is: the lower the risk aversion, the higher the EU. Positive hedged EUs relative to negative unhedged EUs are highlighted. Note that the Positive EUs accompany positive returns (Panels A & B)

	Dow Jones Asia/Pacific Real Estate Securities Index								
	Return	Variance	Expected Utility (x100)						
			k=0.1	k=1	k=2	k=3	k=4	k=10	k=100
Panel A: Full Period, Jan 08 to Dec 10 (In-Sample)									
Unhedged	-0.471%	1.691%	-0.640	-2.162	-3.852	-5.543	-7.234	-17.379	-169.551
Naïve	-0.260%	0.585%	-0.318	-0.844	-1.429	-2.014	-2.598	-6.106	-58.726
OLS	0.025%	0.041%	0.021	-0.017	-0.058	-0.099	-0.141	-0.389	-4.114
VECM	-	-	-	-	-	-	-	-	-
Panel B: GFC Phase 2, Sep 08 to Dec 08 (Out-Sample)									
Unhedged	-0.196%	0.026%	-0.199	-0.222	-0.248	-0.274	-0.299	-0.455	-2.780
Naïve	0.016%	0.026%	0.013	-0.010	-0.036	-0.062	-0.088	-0.243	-2.578
OLS	-0.065%	0.018%	-0.066	-0.082	-0.100	-0.118	-0.136	-0.243	-1.852
VECM	-	-	-	-	-	-	-	-	-
Panel C: GFC Phase 3 & 4, Jan 09 to Jun 09 (Out-Sample)									
Unhedged	0.045%	0.008%	0.044	0.037	0.029	0.021	0.014	-0.033	-0.734
Naïve	-0.026%	0.013%	-0.027	-0.038	-0.051	-0.064	-0.076	-0.152	-1.284
OLS	0.007%	0.006%	0.007	0.001	-0.005	-0.011	-0.017	-0.054	-0.605
VECM	-	-	-	-	-	-	-	-	-

Table 7b (ii): IFAS_DJAPEREITI – Sensitivity of Expected Utility (EU) to Varying Risk Aversion (*k*)

We report in this Table the sensitivity of EU (positive highlighted) to *k*. Note that virtually all the hedged EUs in Panels A & B are higher than unhedged EUs while those in Panel C (except *k*=100) are the exact opposite. The general trend is: the lower the risk aversion, the higher the EU. Positive hedged EUs relative to negative unhedged EUs are highlighted. Note that the Positive EU accompany positive return (Panel A).

	Dow Jones Asia/Pacific REIT Index								
	Return	Variance	Expected Utility (x100)						
			k=0.1	k=1	k=2	k=3	k=4	k=10	k=100
Panel A: Full Period, Jan 08 to Dec 10 (In-Sample)									
Unhedged	-0.405%	1.220%	-0.527	-1.625	-2.846	-4.066	-5.286	-12.608	-122.437
Naïve	-0.194%	0.325%	-0.226	-0.519	-0.845	-1.170	-1.496	-3.448	-32.738
OLS	0.016%	0.029%	0.013	-0.013	-0.043	-0.072	-0.102	-0.278	-2.930
VECM	-	-	-	-	-	-	-	-	-
Panel B: GFC Phase 2, Sep 08 to Dec 08 (Out-Sample)									
Unhedged	-0.224%	0.030%	-0.227	-0.254	-0.284	-0.315	-0.345	-0.528	-3.270
Naïve	-0.012%	0.028%	-0.014	-0.039	-0.067	-0.095	-0.123	-0.290	-2.793
OLS	-0.100%	0.021%	-0.102	-0.120	-0.141	-0.162	-0.182	-0.306	-2.163
VECM	-	-	-	-	-	-	-	-	-
Panel C: GFC Phase 3 & 4, Jan 09 to Jun 09 (Out-Sample)									
Unhedged	0.015%	0.008%	0.015	0.007	-0.001	-0.009	-0.018	-0.067	-0.813
Naïve	-0.055%	0.013%	-0.056	-0.068	-0.081	-0.094	-0.107	-0.184	-1.345
OLS	-0.024%	0.007%	-0.024	-0.030	-0.037	-0.043	-0.050	-0.090	-0.689
VECM	-	-	-	-	-	-	-	-	-

Conclusion

The paper set out to investigate the cross-hedging effectiveness of real estate ETFs (VNQ, IYR, IFEU, IFAS) on different types of real estate securities returns over a period of 75 months (October 2004 to December 2010 for VNQ), 126 months (July 2000 to December 2010 for IYR) and 36 months (IFEU and IFAS). The study covers three geographic regions: US, Europe and Asia. The results of the analyses based on the four metrics of hedging effectiveness used for the study show that the real estate ETFs were very effective in hedging EREIT and all the other types of real estate securities in Europe and Asia (VR of 94% to 99.6%). The risk reduction for hedging REOI with VNQ and IYR was moderately high (ranging from 55% to 80%) but moderate (from 45% to 69%) for hedging MREIT with VNQ and IYR. All the results show that hedging effectiveness is directly related to the R^2. Furthermore, the results show that VECM hedge marginally outperforms OLS hedge when the ETFs and the real estate securities returns are cointegrated. Another finding of note is that hedging effectiveness via VR does not necessarily equate to economic viability. VR for the Pre-GFC period range from 94.14% to 95.27% but all the UIs are negative to imply that hedging the real estate securities with the ETFs during the period would have led to net economic loss. Thus, hedging effectiveness may be better based on UI, which measures the net economic impact of hedging. Finally, the results show that the ETF hedges, based on the UI metric, were, apart from the Pre-GFC period, effective for all types of the sampled real estate securities over all the periods as evidenced by positive UIs – Investors with the lowest risk aversion could have earned positive returns and the highest expected utility from hedging during the GFC. The results from this preliminary study show that real estate ETFs could be effectively used to hedge real estate securities returns.

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