REIT ETFs and Underlying REIT Volatility

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Executive Summary

The U.S. financial markets are continuously evolving as new financial products and innovations are introduced. The effect of these new innovations and products on market performance and investor behavior is of interest to a number of market participants. One recent addition to the market is the REIT Exchange-Traded Fund (ETF).

The purpose of this paper is to determine the effect of REIT ETFs on the volatility of the underlying securities. This study examines the trading activity associated with the introduction of REIT ETFs on the volatility of the component REITs. REIT ETFs generally replicate the constituent stocks of a particular REIT index. The focus is on the first domestic REIT ETF, the DJRE ETF which was introduced on June 12, 2000. Data on the returns and the daily high, low, and market closing price are collected from Bloomberg for five samples: (1) the top 7 constituent REITs of the Dow Jones U.S. REIT (DJRE from hereafter) ETF, (2) the 7 constituent REITs without a derivative market held by the DJRE ETF, (3) a match sample for the top holdings and a matched sample for the 7 REITs without a derivative market, and (4) an appropriate relative equity REIT benchmark.

An examination of the changes in volatility of the underlying REITs prior to ("pre") and subsequent to ("post") the introduction of the REIT ETF is performed using interday GARCH estimation, an intraday volatility measure based on each REITs daily extreme and closing prices, and Levene's homogeneity of variance testing as implemented by Brown and Forsythe (1974). The results show a significant reduction in

intraday volatility after the introduction of the DJRE ETF for both the top 7 holding sample and the non-derivative sample relative to their respective matched sample and an equity REIT benchmark. It is further noted that the greatest reduction is realized by the top holding REIT sample which experienced a reduction in intraday volatility of about 18%, whereas the non derivative sample realized a little more than a 15% decrease in intraday volatility. These numbers are relative to the decrease in intraday volatility over the “pre” and “post” period for the respective matched samples, of -0.039% and -0.1288% and relative to the equity REIT index which experienced a decrease in volatility of -0.0144.

The relationship between the samples daily trading volume, return and S&P 500 intraday volatility is examined, controlling for changes in volatility for a comparable equity REIT index. The results show that, after the introduction of the ETF, volatility for both samples become significantly and positively related to changes in volatility for the S&P 500. Neither sample showed significance with this variable prior to the introduction of the ETF. Moreover, both samples realize a shift in relationship between volatility and return. Prior to introduction of the DJRE ETF the top 7 sample was positively and significantly related to sample return, however after the introduction this relationship becomes insignificant. The non-derivative sample has a positive and significant relationship during the “pre” period but this relationship becomes *negative* and significant at the 1% level during the “post” period.

A GARCH model is used to examine changes in the speed in which information decays and measure the persistence in conditional volatility. A modified Levene homogeneity test is used to determine whether there has been a significant change in the variance of returns for the sample. Results indicate that there may be a slower decay in information for the non-derivative sample without a corresponding change in persistence, however, this sample does not experience a significant change in the variance of its returns. The results for the top holding sample are less conclusive with respect to the speed of decay of information and the volatility persistence, however, it is clear that the sample experiences a significant decrease in the volatility of its returns.

These results provide important insights for operators in the investment markets. The results lead to the conclusion that ETF trading activity by Authorized Participants (large institutional investors) may increase the speed of price adjustment and information efficiency for the top holding sample (this may not be the case for the smaller capitalized and less traded non-derivative sample) which may translate into a significant decrease in volatility.

Given the continued growth in REIT products and a greater understanding of the role these products may play in reducing REIT volatility relative to a REIT benchmark and volatility associated with greater market (such as the S&P 500) we might expect increased investment in REIT securities by institutional investors looking to diversify without increasing risk. Such increased investment should improve the efficiency and liquidity in the overall REIT market. Accordingly, as liquidity and efficiency continues to improve we should expect an increased willingness, on the part of all investors, to allocate more of their investment dollars to real estate securities.

The Introduction of REIT ETFs and Subsequent Changes in Underlying REIT Volatility

I. Introduction

The effect of changes in idiosyncratic volatility has been documented in the academic literature and generates a great deal of interest among investors, practitioners and academicians. Of interest is whether the data show that idiosyncratic volatility levels are increasing relative to market levels and which events may cause large and sustained changes in volatility. Given that the average investor doesn't fully diversify his/her investment portfolio, an increase in idiosyncratic volatility relative to the market potentially erodes the risk-reward tradeoff. Moreover, anecdotal evidence suggests that active money managers and futures traders who are cognizant of such a trend should proceed with caution for similar reasons. As our financial markets continue to expand and new market-transforming financial innovations are introduced, researchers continue to examine the impact these innovations have on volatility.

This study examines the volatility of equity Real Estate Investment Trusts (EREITs) and whether financial innovation in this market, specifically the introduction of the REIT Exchange Traded Fund (ETF), has contributed to significant changes in the volatility of the underlying securities, relative to volatility in the overall equity REIT market. Recently, Lin and Chiang (2005) examine the effect of the Taiwan Top Tracker ETF (ticker TTT) on the volatility of the underlying constituent stocks of that index. They find that the introduction of the Taiwan Tracker ETF *increased* the volatility of certain sector specific constituent stocks while those stocks categorized as "mixed sector" experienced a *decrease* in volatility. In addition, Richie and Madura (2007) examine the impact that the NASDAQ Qube ETF (ticker QQQQ) has on the underlying NASDAQ

100 securities and conclude that overall liquidity increases for these stocks along with a decreased risk realization.

These results show that the ETF, an ever popular and expanding form of basket trading, can have significant yet diverse effects on the underlying securities they track. Recognizing these effects should help REIT investors and practitioners better understand the broader influence of the REIT ETFs and the potential microstructure impacts on the constituent stocks. Subsequently, better investment decisions concerning ones REIT portfolio can be made.

II. REIT Exchange Traded Funds (ETFs)

Many ETFs funds are structured to replicate the holdings of an existing index with the goal of matching the indexes return, yet they offer investors services and investment flexibility traditionally not offered by open-end index mutual funds. As a result, this emerging class of low cost index security has experienced tremendous growth in terms of number of funds offered and total assets under management. The Investment Company Institute reports that domestic ETF equity assets under management increased by 33% over the December 2005 to July 2007 time period, while the number of funds increased a staggering 163%[1]. Further, empirical evidence suggests that a low cost, passive investment strategy can be optimal to active management strategies. Accordingly, as investors continue to increase their demand for ETFs it is of interest to learn the impacts these products may have in the markets on which they trade.

REIT ETFs are funds that generally replicate or base their holdings on the constituent stocks of a REIT index. Our analysis focuses on the first REIT ETF, the Dow Jones US Real Estate Index ETF (DJRE), introduced on June 12, 2000. Since that time,

[1] Data on ETF assets and number of available funds are from the Investment Company Institute website www.ici.org.

over a dozen ETFs with a real estate focus have been introduced with a total market capitalization of approximately $7.2 billion[2].

There are a number of key differences between traditional open-end (real estate) index funds and REIT ETFs. Exchange traded funds can offer investors greater tax efficiency than traditional funds because they generally do not subject investors to the capital gains that can result when a mutual fund liquidates assets to meet redemptions. Additionally, like common stock prices, prices of ETFs can fluctuate throughout the day. ETFs can be traded on margin and can be sold short.

A critical feature of an ETF is its ability to create and redeem outstanding shares in the market. Creations are redemptions for the DJRE can be executed for a maximum fee of $2000[3]. An Authorized Participant[4] may deposit a specified sum of cash and a portfolio of REITs that closely approximate the constituent securities of the DJIF and in return receives a comparable number of Creation units of the ETF. This may be performed in aggregate units of 50,000 shares, increasing the number of ETF outstanding shares in the secondary market. Redemptions are done in a similar fashion: Authorized Participants can turn in shares of the ETF and, in-kind, receive a portfolio of the underlying REITs held by the fund. Redemption activity decreases the number of ETF shares in the market.

The importance of this creation and redemption feature arises from the fact that the actual price an investor pays for an ETF share can deviate from its net asset value (NAV). Market makers enter this market creating and deleting shares in response to

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[2] Market capitalization data are from Bloomberg as of September 5, 2007.

[3] Creation/Redemption fee information is attained from the iShares website and information is as of May 31, 2007. www.ishares.com

[4] An Authorized Participant is anyone pre authorized to initiate creations and redemptions of a particular ETF.

sufficiently large deviations[5]. This creation and redemption activity can trigger sudden and significantly large purchases and sells of the underlying securities held by the ETF. As a result, it is quite possible that the price and returns of the underlying securities held by these ETFs can experience significant and prolonged fluctuations in volatility. IF this is the case then there could be significant implications for active portfolio managers that frequently buy and sell the underlying securities these ETFs hold. The impact could also be significant for REIT derivative investors.

This study examines the changes in EREIT volatility resulting from REIT ETF activity. This is done by examining the change in volatility of the underlying assets of the DJRE. This study also addresses the implications this relationship may have as investors and portfolio managers make investment decisions.

III. Price and Return Volatility

Derivative securities such as index and single stock futures have become commonplace in the financial markets and are frequently examined in the literature. A major concern for market participants is whether the introduction of derivative type securities affects the volatility of the underlying spot market.

Research on stock market volatility before and after the introduction of stock index futures has produced mixed results. A study by Edwards (1988) finds no evidence of futures having a destabilizing effect on the underlying asset. On the other hand, Harris (1989) finds a small increase in volatility for S&P 500 stocks. A major criticism of these type studies is that they often fail to account for changes in the broad market factors. For

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[5] Typically, creations and deletions are initiated by large institutional investors such as pensions, mutual funds and market makers. This means that their trades are large enough to quickly close any sizable pricing gaps with lower trading costs.

example, changes in volatility may be ascribed erroneously to futures trading when, in fact, they may have been caused by changes in economic factors.

A 1997 study by Kan examines the effect of the introduction of an index futures market on the volatility of individual constituent stocks (as opposed to the underlying index). The main objective of the study was to test the hypothesis that index futures trading increases the volatility of its underlying assets. The study uses daily return variance of individual constituent stocks from the PACAP Daily Stock Price and Returns file and Financial Statements File for 1983 to 1989. The study compares two groups of stocks: the HIS constituent stocks and non-constituents stocks. The return volatilities of individual stocks between consecutive sub-periods are compared after adjusting for factors known to affect return volatilities. The results show no evidence to support the hypothesis that trading in the HIS futures increases the volatilities of its constituent stocks in either the short-run or the long-run.

Chang, Cheng, and Pinegar (1999), in a subsequent study, propose a new method to examine whether stock index futures affect stock market volatility by decomposing spot portfolio volatility into the cross-sectional dispersion and average volatility of returns of the portfolio's constituent securities. Using Nikkei and non-Nekkei stocks, the total sample consisted of firms listed on the Tokyo Stock Exchange. They find that, absent trading restrictions, futures trading increases spot portfolio volatility but that the volatility impact does not spill over to stocks against which futures are not traded. This absence of spillover suggests that the volatility impact of futures trading (at least on Nikkei stocks) is not spuriously caused by extraneous economic disturbances.

Several studies have examined the market affects given the ETFs introduction. Chu, Hsieh, and Tse (1999) examine impact Standard and Poor's Depository Receipts

(SPDRs) have on the S&P 500 Index. They find that, although futures prices often lead the market, SPDRs contribute significantly to the process of price discovery. Switzer, Varson, and Zghidi (2000) find a significant reduction in mispricing between spot index and futures since the introduction of SPDRs.

In a later study, Chu and Hsieh (2002) examine both the pricing efficiency and arbitrage opportunities between SPDRs and the S&P 500 index futures and the impact of SPDRs on spot-futures market efficiency. Using intraday trade-by-trade data, their tests of ex-post boundary violations indicate that the introduction of SPDRs facilitates short arbitrage thereby improving the pricing efficiency at the lower bound. The post-SPDR period shows a smaller percentage of mispricings and shorter periods of lower bound violations. Their results are consistent with the hypothesis that SPDRs facilitate short arbitrage, simplifying the process of shorting the cash index against the futures.

Richie and Madura (2007) point out that exchange-traded funds differ from futures contracts in that participation in ETFs does not require the same level of expertise as participation in the futures markets. Some studies have examined the liquidity effects of ETFs on the underlying stocks. Hedge and McDermott (2004) examine the effect of the introduction of two ETFs on the liquidity of their component stocks and find an increase in liquidity for the underlying stocks upon the introduction of the ETFs. Richie and Madura (2007) extend the work of Hedge and McDermott by examining whether these liquidity effects differ by the weighting of the components. Their major interest was whether the creation of the Qube ETF, which tracks the 30 Dow Jones stocks, affects the liquidity and risk of the underlying stocks. They find that, following the creation of the Qube in 1999, the liquidity of the component stocks increased. Interestingly, the less heavily weighted components experienced greater relative liquidity than the more heavily weighted components.

This study is the first, to our knowledge, to focus on the evolving and rapidly expanding real estate market. By examining the introduction of the Dow Jones US Real Estate Index Fund (DJRE) this study determines the effect on (1) the return volatility of the top 7 constituent REITs held by the REIT ETF and (2) the volatility of those constituent REITs held by DJRE that did not have a pre-existing derivative market (i.e. options, futures, etc) during our sample period. The focus is on the top 7 constituent REITs of the DJRE since these REITs tend to have the largest market capitalizations and liquidity and are widely held by portfolio managers with real estate exposure.

We seek further evidence of whether the ETF acts to stabilize or destabilize the volatility of the market by examining a sample of REITs held by the DJRE ETF that do not have a pre-existing derivative market[6] in place during the sample period to draw inference to whether the ETF acts to stabilize or destabilize the volatility in this market. This is accomplished by examining changes in volatility for the sample during a "pre-ETF" period and a "post-ETF" period relative to a corresponding match sample, controlling for overall REIT market volatility.

Casual observation shows that the volatility of equity REITs over the January 1999 to January 2003 period was consistently and seemingly significantly less than S&P 500 intraday volatility. This is illustrated in Figure 1. Figure 1 presents a time series of the daily percentage volatility for the S&P 500 and the Bloomberg equity REIT indices for the period January 1999 to December 2004. Volatility is measured by Equation (1) presented in section IV and Figure 1 presents the polynomial trend line of sixth order.

[6] All REITs in the top 7 holding sample have a pre-existing derivative market in place, i.e, there are either options or futures trading on these REITs.

For the period 1999-2003, volatility in the equity REIT market is less than that of the S&P 500 and seems to experience fewer and smaller volatility swings. However, volatility for the S&P 500 starts a significant decline around January of 2003 through approximately the middle of 2004 and REIT volatility appears to increase over the 2004 time period. Figure 1 also shows that the sample volatility converges around January of 2004 and for the first time over the sample period REIT volatility is greater than S&P 500 volatility.

IV. The Data

Daily high, low, and market closing price, along with return are collected from Bloomberg for three samples: (1) the top 7 constituent REITs of the Dow Jones US Real Estate Index ETF (IYR) , (2) the 7 constituent REITs held by DJRE ETF without a derivative market, (3) respective matched samples, and (4) an appropriate relative benchmark. Benchmark returns and benchmark volatility are based on the Bloomberg Real Estate Investment Trust Index (BBREIT). Introduced on December 31, 1993, this capitalization-weighted index excludes mortgage REITs and EREITs less than $15 million.

A matched sample is compiled for the top seven constituent EREITs and non derivative REIT ETFs by matching on market capitalization, funds from operations and dividends/funds from operations. These criteria are chosen to ensure that the match sample is of similar size, cash flow and payout cycle. The matched sample is used in the initial volatility and variance estimations for out of sample comparison. Data are collected over the January 1, 1999 to December 31, 2004 sample period and are divided by a "pre" and "post" period signifying whether the estimations analyze the period prior to the introduction of the REIT ETF or the period after its introduction.[7]

V. Methodology

This analysis examines the impact of the introduction of REIT ETFs on the volatility of the underlying securities by analyzing the impact of the DJRE ETF on the constituent REITs. The analysis uses interday GARCH estimation, an intraday volatility measure based on each REITs daily extreme and closing price values, and Levene's homogeneity of variance testing. First, the extreme value measure of volatility is defined as the following:

$$EV_{t,i} = [(MAX_{t,i} - MIN_{t,i}) / \{(MAX_{t,i} + MIN_{t,i}) / 2\}] \qquad (1)$$

where EV represents the daily volatility for a specific REIT/index. MAX and MIN are the daily "hi" and "low" market price for each REIT/index. This methodology is similar to that found in Parkinson (1980), Alizadeh, Brandt and Diebold (2002) and more recently by Vipul (2006). Daily closing price and realized volatility are often used as an alternative to the extreme value volatility measure. However Alizadeh, et al. (2002) point out that using an extreme value measure is most ideal, even over realized volatility, given the presence of certain microstructure issues such as bid-ask bounce. EV is also an attractive measure since it should capture intraday volatility. Vipul (2006) points out that EV is proportional to the measure of standard deviation and therefore should adequately serve as a comparable volatility measure across time.[8]

The daily volatility measure (EV) is used in the following cross-sectional OLS regression:

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[7] The results over the November 10, 1999 to January 26, 2001 time period are reported in the tables and this period is utilized given that the second REIT ETF is introduced on June 29, 2001 and that ETF holds a number of the same REITs held by the Dow Jones Real Estate ETF. Accordingly, in order to isolate our results we form the initial sample period to end prior to the introduction of the second ETF.
[8] See Parkinson (1980) for a discussion on EV as a comparable measure of standard deviation.

$$EV_{t,i} = \beta_0 + \beta_1 NDXVol_t + \beta_2 Volume_{t,i} + \beta_3 Return_{t,i} + \beta_4 S\&PVol_t + \varepsilon_t \qquad (2)$$

where NDXVol is the volatility (EV calculation) for the benchmark EREIT BBREIT; Volume is the natural log of daily volume for REIT i on day t; and Return is the return on REIT i on day t. NDXVol is used to control for the general level of volatility in the general EREIT market. Volume and Return are included to determine whether there is a change in the relationship between volume levels and return and the sample volatility given the period prior and subsequent to the introduction of the REIT ETF. S&P 500 daily intraday volatility is included to examine any shift in the relationship between the volatilities in these two security types. A dummy variable is used to indicate whether the regression measures the period prior to introduction and subsequent to the introduction. The Dummy variable is 1= during the period after the REIT ETF was introduced and 0 otherwise. The regression uses Newey-West (1987) standard errors to account for heteroskedasticity and autocorrelation.

GARCH volatility is also used to estimate changes in the volatility to detect the persistence in changes in sample volatility. Using the variance of daily returns, GARCH estimates interday volatility but does not capture intraday volatility which is why EV volatility is also computed. We estimate a GARCH (1,1) which has been found to be the most robust and parsimonious estimation of volatility in previous studies (see Engle (1993 and 2001) for further discussion). The GARCH model is:

$$h_t = \alpha_o + \alpha_1 \varepsilon^2_{t-1} + \beta_2 h^2_{t-1} \qquad (3)$$

where h_t is the unconditional variance of ε_t.

A modified Levene homogeneity test is used to determine whether there has been a significant change in the variance of returns for the respective samples. A modified Levene is computed as follows:

$$W = \frac{(N-k)}{(k-1)} \frac{\sum_{i=1}^{k} N_i (Z_{i\cdot} - Z_{\cdot\cdot})^2}{\sum_{i=1}^{k} \sum_{j=1}^{N_i} (Z_{ij} - Z_{i\cdot})^2}, \quad (4)$$

where

- $Z_{ij} = |Y_{ij} - \bar{Y}_{i\cdot}|$ with $\bar{Y}_{i\cdot}$ the mean of group *i*, (5)
- $Z_{\cdot\cdot} = \frac{1}{N} \sum_{i=1}^{k} \sum_{j=1}^{N_i} Z_{ij}$ is the mean of all Z_{ij}, (6)
- $Z_{i\cdot} = \frac{1}{N_i} \sum_{j=1}^{N_i} Z_{ij}$ is the mean of the Z_{ij} for group *i*. (7)

VI. Results

Volatility is first analyzed using an intraday measure of price volatility that is consistent with a measure of standard deviation. Table 1 presents the change in daily intraday volatility for the top 7 REITs held by the iShares DJRE ETF and separately for those REITS held by this ETF that do not have a derivative market in place. Volatility results are also presented for the matched sample and the Bloomberg equity REIT index. Changes in volatility are examined over the period prior to the introduction of the ETF (November 10, 1999 to May 19, 2000) and over a post introduction period (July 17, 2000 to January 26, 2001). The Wilcoxon-Mann-Whitney test, a non-parametric test analog to a t-test assuming independent samples, is used to determine the significance of the percentage change in volatility across the pre and post ETF periods. The Wilcoxon-Mann Whitney test does not assume a normally distributed dependent variable (intraday volatility).

Results indicate a significant reduction in volatility after the introduction of the DJRE ETF. This reduction is significant at the 1% level for both samples, however, relative to a respective matched sample, the reduction in intraday volatility is notably greater for the top holding REIT sample (a 17.99% reduction in volatility compared to a 3.85% reduction for the matched sample) than for the non-derivative sample (a 15.35% reduction in volatility compared to a 12.88% reduction for the matched sample). Table 1 also presents the change in volatility over the sample period for the Bloomberg equity REIT index. The Bloomberg equity index is a proxy for the general REIT market. Results indicate that both samples experienced significant decreases in intraday volatility relative to a benchmark and their respective matched sample.

Again, the results indicate that the top holding REIT sample realized the largest decrease in volatility. Similar to the findings of Kan (1997) and Richie and Madura (2007), this result may indicate that DJRE ETF trading activity may assist in the stabilization of the market but that this stabilization effect may vary across security characteristics. Specifically, the REITs in the sample experiencing the greatest decrease in volatility also have significantly larger market capitalizations and experienced a significant positive change in trading volume relative to the alternative sample (the non-derivative REIT sample). The top REIT sample experienced an increase in daily trading volume by just over 16% while the non-derivative sample experienced a *decrease* in daily trading volume 8%. Results may indicate that increased trading on the part of Authorized Participants whom frequently enter the market to correct the premiums and discounts of the ETFs holding the underlying REITs in question, may serve to stabilize this market and do so to a greater extent for those larger capitalized REITs in the market[9].

To gain further insight to the preliminary findings, the relationship between sample daily trading volume, return, the daily intraday volatility on the S&P 500 and

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[9] This may be the case given that Authorized Participants may also be dealers holding inventory. Accordingly, these participants may be more likely to hold inventory of well capitalized REITs over smaller capitalized REITs as is the case with the non-derivative sample. Accordingly, these market participants may be more willing/able to actively trade and correct pricing imbalances involving the larger capitalized sample.

sample REIT daily volatility, controlling for volatility on a comparable equity REIT index. Table 2 offers the results from estimating equation (2). The model uses OLS regression with Newey-West corrected test statistics to examine potential shifts in the relationship between daily volatility for the top 7 REIT holdings of the Dow Jones REIT ETF and those securities held by the REIT ETF that do not have a derivative market in place during the sample period and those variables previously mentioned. Panel A presents the estimation results for the top holdings sample and Panel B presents the results for the non-derivative sample. The results show that, after the introduction of the ETF, volatility for both samples become significantly and positively related to changes in volatility for the S&P 500. Neither sample showed significance with this variable prior to the introduction of the ETF. Moreover, both samples realize a shift in relationship between volatility and return. Prior to introduction of the DJRE ETF the top 7 sample was positively and significantly related to sample return, however after the introduction this relationship becomes insignificant. The non-derivative sample has a positive and significant relationship during the "pre" period but this relationship becomes *negative* and significant at the 1% level during the "post" period.

This finding, in concert with the finding from Table 1, may lend further evidence that the trading activity by Authorized Participants (large institutional investors) may be driving a significant portion of the decrease in volatility and variance experienced by the top holding sample. We do not see a significant change in the variance of returns nor do we see the change in intraday volatility for the non-derivative sample that we see for the top holdings sample. Accordingly, we notice that the relationship between volatility and return remain constant over the "pre" and "post" period for the non-derivative sample. However, the top holding sample experiences a significant decrease in both its intraday volatility and the variance in its return. The empirical evidence shows that after the introduction of the ETF, this samples volatility is no longer significantly related to return. One reasonable explanation might be that this decrease in volatility is significantly less correlated with its return series, yet may tend to fluctuate (decrease) via the stabilizing effect of Authorized Participants trading activity via a potential increase in the speed of price adjustment and information efficiency for this sample (see Sias and Starks, 1997).

Table 3 presents the results from the Levenes homogeneity of variance test and simply indicates that the top REIT sample realized a significant decrease in return variance over the "pre ETF" and "post ETF" period. There was not a significant difference in return variance for the non-derivative sample.

Thus far we have estimated the change in variance and volatility of the respective samples and examined whether the samples experienced changes in the relationship between trading volume, return, S&P volatility and sample intraday volatility. When examining volatility it has become standard to estimate a generalized autoregressive conditional heteroskedasticity model (GARCH). A GARCH model is used here to determine whether shifts occur in the rate of information decay and whether there is persistence in conditional volatility. A GARCH model is estimated for both samples over both the "pre" and "post" ETF sample period. Three of the 4 estimations have a GARCH (1,) specification while one, the "post" period for the non-derivative sample, is better specified as a GARCH (2,1). Results are presented in Table 4. Panel A of Table 4 presents the GARCH results for the sample of REITs held by the ETF without a pre-existing derivative market. These results are presented for the period prior to the introduction of the REIT ETF (Pre period) and the period following its introduction (Post period). For the non-derivative market sample, the results indicate a shift to a slower decay in information during the period after the introduction of the REIT ETF. This is indicted by the shift to the AR (2) specification. The results for the top holding REITs, as presented in Panle B, are not more difficult to interpret. It is not clear that there has been a definitive shift in the speed of information decay or volatility persistence. We leave further modeling of volatility to future research.

VII. Summary and Conclusions

Investors are concerned with how financial innovation in the investment markets affects the return/risk characteristics of securities within these markets. In particular, changes in the idiosyncratic volatility of securities are of interest to a number of investment market participants including individual investors seeking to diversify risk and the investment managers who represent them. In addition, researchers are continually examining the causes and effects of financial market operations and the risk and return characteristics of investment options.

This study has examined whether the trading activity associated with the introduction of REIT ETFs has had a significant effect on the volatility of the component REITs they hold. REIT ETFs generally replicate the constituent stocks of a particular REIT index. The focus has been on the introduction of DJRE ETF since it was the first domestic REIT ETF. An examination of the changes in volatility of the underlying REITs prior to and subsequent to ETF introduction was performed using interday GARCH estimation, an intraday volatility measure based on each REITs daily extreme and closing price values, and Levenes homogeneity of variance testing. The results show a significant reduction in volatility after the introduction of the DJRE ETF for both the top 7 holdings and the non-derivative REITs, relative to matched samples, with a notably greater reduction for the top holding REIT sample. Moreover, the constituent REITs with the larger market capitalization and trading volume realize a significant decrease in return variance.

The relationship between daily trading volume, return, the daily intraday volatility on the S&P 500 and sample REIT daily volatility, controlling for volatility on a comparable equity REIT index, is examined. The results show that, after the introduction of the ETF, volatility for both samples become significantly and positively related to changes in volatility in the S&P 500. Neither sample showed significance with this variable prior to the introduction of the ETF. Moreover, both samples realize a shift in relationship between volatility and return. Prior to introduction of the DJRE ETF the top holding sample was positively and significantly related to sample return, however after the introduction this relationship becomes insignificant. The non-derivative sample has a positive and significant relationship during the "pre" period but this relationship becomes *negative* and significant at the 1% level during the "post" period.

These findings, in concert, may indicate that the trading activity by Authorized Participants (large institutional investors) may be driving a significant portion of the decrease in volatility and variance experienced by the top holding sample by increasing the speed of price adjustment and information efficiency for large capitalization and broadly traded REITs. Given the continued growth in REIT ETF products and a greater understanding of the role REIT ETFs play in reducing REIT volatility, as liquidity and efficiency continues to improve, we should expect an increased willingness, on the part of investors, to allocate more of their investment dollars to real estate securities.

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Change In Intraday Volatility
Table 1. Average "EV" Volatility

November 10, 1999 through May 19, 2000 represents the "pre-ETF" period and July 19, 2000 through January 26, 2001 represents the "post-ETF" period.

	Pre-ETF period		Post-ETF period		
Sample	Obs	Average Volatility	Obs	Average Volatility	Change in Volatility (%)
Top REIT Holdings of IYR	1064	0.0239	1064	0.0196	-0.1799*
Top REIT Matched Sample	1064	0.0312	1064	0.0300	-0.0385
Non-derivative IYR Holdings	1064	0.02135	1064	0.01823	-0.1535*
Non-derivative Match	1064	0.02485	1064	0.02269	-0.1288
Bloomberg Index	133	0.0069	133	0.0068	-0.0144

*significance at the 1% level

Table 2. Volatility Regression Analysis

Table 2 presents results examining the relationship between sample volatility and four independent variables. The variables include the daily volatility of the Bloomberg REIT Index (NDXVol), the natural log of the individual sample REITs daily volume (SPLVol), the sample REIT daily return (Return) and the daily volatility on the S&P 500. Volatility is measured as presented in equation 1. The regression is estimated using OLS with Newey-West (1987) corrected standard errors to correct for heteroskedasticity and autocorrelation. The equation is presented as follows:

$$EV_{t,i} = \beta_0 + \beta_1 NDXVol_t + \beta_2 Volume_{t,i} + \beta_3 Return_{t,i} + \beta_4 S\&PVol_t + \varepsilon_t \quad (2)$$

Panel A: Top 7 holdings in IYR

	Pre-ETF Period			Post-ETF Period		
	RSq=.20			RSq=.27		
Variable	**Coefficient**	**Standard Error**	**Test Statistic**	**Coefficient**	**Standard Error**	**Test Statistic**
Intercept	-0.0764	0.0061	-12.48*	-0.0449	0.0044	-10.10*
NDXVol	.2576	.1022	2.52**	0.3342	0.0801	4.17*
Volume	0.0075	0.0004	16.98*	0.0049	0.0004	13.36*
Return	0.0947	0.0236	4.01*	0.0062	0.0251	0.25
S&P Vol	0.0429	0.0441	0.97	0.2025	0.0461	4.39*

Panel B: REITs in IYR without derivative market

	Pre-ETF Period			Post-ETF Period		
	RSq = .28			RSq =.33		
Variable	**Coefficient**	**Standard Error**	**Test Statistic**	**Coefficient**	**Standard Error**	**Test Statistic**
Intercept	-0.0855	0.0058	-14.74*	-0.1224	0.0064	-19.26*
NDXVol	0.2404	0.0899	2.67*	0.1338	0.1043	1.28
Volume	0.0088	0.0004	19.56*	0.0123	0.0006	22.08*
Return	0.0613	0.232	2.64*	-0.1154	0.0265	-4.35*
S&P Vol	0.0167	0.0391	0.43	0.1101	0.0597	1.84***

*Significant at the 1% level.

**Significant at the 5% level.

***Significant at the 10% level.

Table 3
Equality of Variance Estimation

Non-derivative Sample

Variable	Mean Return	Std Dev	F Value
Pre	0.0006	0.0176	0.18
Post	0.0004	0.0188	

Top REIT Sample

Variable	Mean Return	Std Dev	F Value
Pre	0.0012	0.0192	8.36*
Post	0.0003	0.0153	

*Significant at the 1% level.

Table 4

GARCH Estimation

Panel A

Non-derivative Sample (Pre-Period)

Variable	Variance Equation Estimate	Standard Error	Test Statistic
ARCH1	0.0461	0.0083	5.52*
GARCH1	0.9243	0.0147	62.85*

Non-derivative Sample (Post-Period)

Variable	Variance Equation Estimate	Standard Error	Test Statistic
ARCH2	0.9049	0.0207	43.69*
GARCH1	0.0000	0	4742.2*

Panel B

Top Holdings Sample (Pre-Period)

Variable	Variance Equation Estimate	Standard Error	Test Statistic
ARCH1	2.62E-23	0.0000	1
GARCH1	1.80E-06	0.0000	0.0001*

Top Holdings Sample (Post-Period)

Variable	Variance Equation Estimate	Standard Error	Test Statistic
ARCH1	0.0919	0.0326	2.82*
GARCH1	0.2335	0.1986	1.18

*Significant at the 1% level.

Figure 1
REIT Benchmark and S&P 500 Volatility

Figure 1 displays the relationship between daily change in intraday volatility for the S&P 500 and the Bloomberg REIT Index over the January 1999 through December 2004 time period. A polynomial trend line of 6th order is also plotted. Intraday volatility is as calculated in equation (1).