Uncovering Volatility Dynamics in Daily REIT Returns

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Abstract

Using a time-varying approach, this paper examines the dynamics of volatility in the REIT sector. The results highlight the attractiveness and suitability of using GARCH based approaches in the modeling of daily REIT volatility. The paper examines the influencing factors on REIT volatility, documenting the return and volatility linkages between REIT sub-sectors and also examines the influence of other US equity series. The results contrast with previous studies of monthly REIT volatility. Linkages within the REIT sector and with related sectors such as value stocks are diminished, while the general influence of market sentiment, coming through the large cap indices is enhanced. This would indicate that on a daily basis general market sentiment plays a more fundamental role than more intuitive relationships within the capital markets.

Uncovering Volatility Dynamics in Daily REIT Returns

Introduction

Recent years have seen a structural change in the attitude of investors to real estate securities. Much of this shift has accompanied the strong performance in many markets of real estate securities. In addition to the strong recent performance of the sector, there have been a number of structural changes in the sector that have further increased its attractiveness. The growth in the REIT sector in the United States is of particular interest. The REIT structure overcomes many of the limitations in conventional indirect real estate vehicles, in particular the issue of tax transparency. The standard corporate structure used in countries such as the UK provides a disincentive for many institutional investors from holding such securities, and a corresponding advantage in favor of direct investment. The growth in REIT type structures in non-US markets further illustrates the advantage to such structures. In the US, the inclusion of REITs in major indices such as the S&P500 has also increased investor awareness and investment, particularly from index based fund managers. The combination of factors such as this, the limitations on REITs in relation to dividend payments and the strong relative performance of the sector in the aftermath of the collapse of the technology bubble have resulted in increased fund flows into the sector. Ling & Naranjo (2004) illustrate the impact of the flow of funds into REITs and the subsequent impact upon REIT returns.

In addition to returns, investors should also be interested in the volatility of these markets given the risk-return trade-off underpinning the performance of financial markets. The current paper incorporates this motivation by examining the dynamics of daily volatility in the REIT sector. Much of the research concerning REITs has been primarily concerned with either the sectors performance as a portfolio asset or the financial characteristics of REITs. Relatively few studies have examined the relationship between REITs and mainstream capital market assets. However, as the REIT sector has developed, the direct and indirect influence of the broader capital markets is of increasing importance in the context of REITs as broader investor awareness increases. This is particular so in relation to the issue of volatility. This study aims to assess not only the dynamics underlying REIT volatility, but also to examine the influence of other capital market assets on the sector. The development of the sector may result in a changing relationship between REITs and other equity sectors, particularly at higher frequencies of data. Previous studies of REITs have largely used monthly data. The use of daily data in this paper is a deliberate choice. While a common criticism of the use of daily data in academic studies is the noise contained within it, increased investment in REITs, particularly from more active investors, is likely to see increased daily trading and therefore daily volatility in the asset. Based on data from SNL Financial the average level of daily Equity REIT volume has

increased from just over 2.5m shares in 1993 to over 40m shares in 2005. The analysis of volatility also has important implications in terms of issues such as risk management and the implementation of hedging strategies. In relation to risk measures such as value-at-risk, the estimation of volatility is a key element. The impact of increased investor awareness on daily trading will therefore in all likelihood result in the increased need for the accurate assessment of both volatility itself and the broader linkages between REITs and other equity sectors on a daily basis.

While a literature has developed that has examined the linkages with other capital market assets, the majority of papers have examined linkages in the first moment of the return series and examined the issue of integration and segmentation; for example, Liu et al. (1990) cannot reject the hypothesis that REITs are integrated with common equities. Evidence with regard to the integration of REITs and common stocks has also been found in studies such as Mei & Lee (1994) and Li & Wang (1995). Ling & Naranjo (1999) use multi-factor asset pricing techniques to examine whether there is any evidence of integration between direct real estate, REITs and common stocks. As with previous studies, REITs are found to be integrated with non-real estate equities, however, no such evidence is found in relation to the direct market, even when this data is adjusted for smoothing. Wilson & Okunev (1996) examine the Australian, American and British indirect real estate and equity markets, finding in all three markets an absence of any cointegrating relationships. Okunev & Wilson (1997) use a non-linear integration test to examine the relationship between REITs and the S&P 500 Composite. The results show that while the two markets may be related in a non-linear fashion, the level of deviations between the two can be extensive, with the degree of mean reversion quite slow. For example, the authors find that the half-life of deviations is 30 months is some cases.

A number of studies have examined the issue of substitutability between different REIT sectors, with most emphasis placed on the equity and mortgage sectors. Seck (1996) argues that equity and mortgage REITs are not substitutable due to the fact that they respond differently to common factors. Similar evidence is reported by papers such as Peterson & Hsieh (1997) and Glascock et al. (2000). Glascock et al. (2000) report that while the sectors were substitutable prior to 1992, with evidence of cointegration between the two sectors and common driving forces, this affect is not evident in the post-1992 environment. This result is similar to many that have examined REITs, showing that the early nineties saw a turning point in the price behavior of REITs, and in particular Equity REITs. To a large extent this shift was due to the reforms contained in the 1986 Tax Reform Act, which eliminated many of the tax based investment incentives of REITs. Prior to this legislation many REITs had been effectively established as tax shelters. A recent paper by Lee & Chiang (2004) however, finds further evidence of commonalities between the equity and mortgage

sectors. The authors use a variance ratio test; with the results supporting the hypothesis that the two sectors are substitutable, even post early nineties. He (1998) finds evidence to support the notion that a causal relationship exists from Equity REITs to Mortgage REITs in the USA, with further evidence finding that the two sectors are cointegrated.

In contrast to the literature that has examined the return behavior of REITs, few have examined volatility in the sector. Stevenson (2002) examined volatility spillovers within different REIT sectors and between REITs and the equity and fixed-income markets. The paper examined monthly data over the period 1975 to 2001. The study finds that volatility in Equity REITs has a significant influence on the other sub-sectors of the market and that a number of patterns emerge with regard to the influence of other asset classes. The primary results indicate that the REIT sector is generally influenced more strongly by volatility in small cap stocks and in firms classified as value stocks. These findings are not surprising given the average size of REITs and the fundamental nature of them. The S&P 500 has a mixed and inconsistent relationship with REITs, while there is no evidence of a positive relationship in volatility between the fixed income sector and Mortgage REITs. Devaney (2001) uses a GARCH-M model on monthly REIT data, primarily to examine the relationship between REIT volatility and interest rates. The paper finds significant influences on REIT returns from interest rate movements. The author does however find that in most cases the results for Equity REITs are not significant, with stronger findings reported for the Mortgage sector, as would to some extent be expected due to the nature of firms. Two recent working papers, Winniford (2003) and Najand & Lin (2004) both provide further evidence concerning the dynamics of daily volatility in the REIT sector. Najand & Lin (2004) utilize both a GARCH and GARCH-M model in their analysis of daily REIT volatility. The authors report evidence that would suggest that volatility shocks are persistent. Winniford (2003) concentrates on seasonality in REIT volatility. The author finds strong evidence that volatility in Equity REITs does vary on a seasonal basis, with observed increased volatility in April, June, September, October and November.

The current paper extends previous studies in a number of ways. Firstly, in comparison to both Stevenson (2002) and Devaney (2001) it uses daily rather than monthly data. The use of daily data allows a deeper analysis of market based transmissions in volatility and also overcomes the problems inherent in using monthly REIT data due to the structural break in the early nineties. While a common criticism of using daily data is the noise contained within it, the use of higher frequency data allows an examination of whether previously reported results are stable over different data frequencies. In addition, the growth in the sector and especially the increased awareness from a broader class of investors is likely to result in an increase in

daily volatility due to higher trading levels. These could result in changing dynamics in daily REIT volatility. Secondly, in comparison to the previous studies of daily volatility the paper extends the analysis in a number of respects. While, for example, Najand & Lin (2004) do incorporate the general market into their model, they do not include other equity indices, and in particular, they do not examine the influence of value stocks. Likewise, Winniford (2003) does not include such equity sectors in his analysis. This is despite the strong empirical evidence in the literature concerning the linkages between REITs and the value sector. In addition to the mainstream S&P 500 the current paper also analyses the interlinkages with the value and growth sectors as well as the NASDAQ which acts as a proxy for the technology sector.

The paper is laid out as follows. The following section provides an initial description of the empirical approach used in the study, describes the data used and provides preliminary statistics to assess the suitability of a GARCH approach in modeling daily REIT volatility. Section 3 contains the main empirical analysis, while the final section provides concluding comments.

Modeling Framework

The main empirical analysis is undertaken in a GARCH (Generalized Autoregressive Conditional Heteroscedasticity) framework. GARCH models allow the simultaneous modeling of both the first and second moments of the return series' and provide a more efficient means of modeling time-series'. The use of ARCH based models allows us to examine the interlinkages between the different assets in terms of their second moment, effectively examining causal relationships in volatility. Conventional econometric time-series models assume that the variance of the error term is constant. This assumption of homoscedasticity is however often problematic in the analysis of financial time series', with the clustering of volatility being a prime example of a situation where this assumption may be violated.

The return generating process is modeled in a time-varying fashion:

$$R_t = bZ_t + \varepsilon_t \tag{1}$$

$$\varepsilon_t | I_{t-1} \sim N(0, H_t) \tag{2}$$

$$H_t = \alpha_0 + \sum \alpha_i \varepsilon_{t-i}^2 + \sum \beta_j H_{t-j}^2 \tag{3}$$

Where the mean is described by a first order VAR, and univariate volatility follows a GARCH (1, 1) process. The main advantage to the GARCH process proposed by Bollerslev (1986) is that it allows for lagged squared returns and volatility in the modeling process. A number of explanatory variables are also included in the mean and volatility specifications detailing the influences on the return generating process.

The data used in this paper consists of daily data for the period June 1992 to October 2005. For the REIT sector the SNL Financial indices are used. In order to examine possible changing dynamics of daily Equity REIT behavior the sample is broken into three sub-periods. The first extends from the start of the analysis until the end of 1996. This was a period characterized by rapid growth in the REIT sector, with a large increase in REIT IPOs. The second period, 1997 to March 2000 contains the prime period of the technology boom. From a REIT perspective this period saw substantial underperformance of the sector in comparison to not only technology stocks in particular but also to the general market, as can be observed in Exhibit 1. The final sub-period analyzed comprises of data from April 2000 onwards. This period, following the correction in the technology sector, has seen the REIT sector being one of the best performing in the broader equity markets.

Summary statistics for daily REIT returns are outlined in Exhibit 2. The changes in market conditions are readily observed in the average daily return figures, with a negative figure of the middle sub-period, 1997-2000. Evidence of non-normality, provided through the kurtosis and Jaque-Bera statistics is also evident. One interesting, and in the context of this study interesting element in these figures though is the increasing trend in the standard deviation of the REIT sector across the different sub-periods. This is an aspect that will be examined in closer depth below[1]. A time series plot of daily REIT returns is displayed in Exhibit 3. All of the returns are time varying with evidence of volatility clustering in that high levels of volatility tend to be concentrated together. Again, the increased level of volatility over the course of the overall sample is evident.

{Insert Exhibits 1, 2 & 3}

An initial examination of the dynamics of REIT returns and volatility can be undertaken by assessing the dependencies present in the return and volatility series through the autocorrelation function (ACF). Exhibit 4 displays the ACF over 36 lags. Notwithstanding the significant dependency of returns in the first lag due to non-synchronous trading, there is a general lack of significant autocorrelation in all returns series. The high first order autocorrelation reported is to some extent expected due to the small average relative size of

REITs and the average level of daily trading in the sector. However, there is a marked trend in the ACF across the three sub-periods. In particular, the autocorrelation reported at short lags reduces substantially. This is evidence of the growing maturity and level of trading in the REIT sector and provides justification for the examination of distinct sub-periods in this study.

{Insert Exhibit 4}

Exhibits 5, 6 and 7 report information pertaining to the volatility of REITs. The data contained in Exhibits 5 and 6 use the squared daily returns to detail characteristics of the volatility series, while Exhibit 7 graphically displays 120 day rolling standard deviations. As already observed volatility increases substantially over the time period. This to a large extent is supportive of the return ACF results previously noted, in that the growing level of trading and investor awareness of REITs has led to a change in the return and volatility dynamics of the sector. Exhibit 5 shows an increase in mean squared returns across the sub-periods, while Exhibit 7 shows a distinct increasing trend in the standard deviation of the series. Of further interest are the ACF results reported in Exhibit 6. While the return ACF's saw a decrease as the sector matured and grew, the trend in relation to autocorrelation in volatility is the reverse. Particularly in relation to the shorter lags there is an increase in volatility persistence as the sample is extended. This would imply greater degree's of volatility clustering as the market has grown and trading increased. The strong serial correlation of volatility indicates the existence of ARCH effects and validities the application of GARCH related processes.

{Insert Exhibit 5, 6 & 7}

Empirical Analysis of REIT Volatility

Exhibit 8 reports the results from the fitting of the GARCH (1,1) model. The estimations for each series are for the relevant sample period and are made using maximum likelihood methods of the conditioning variables. In general the findings are in line with expectations for the GARCH parameters with significant parameters. The set of explanatory variables included for analysis for each REIT index are a range of other equity sectors and a number of additional variables. The influence of the equity markets is proxied by the inclusion of a number of alternative equity market indices. The S&P500 Composite is used as a proxy of the overall market. New economy firms are proxied by the NASDAQ Composite, while the S&P small-cap value and growth indices are also incorporated into the analysis. The rationale behind the inclusion of value

indices in particular concerns the characteristics of REITs. Most REITs are mid and small cap stocks and due to the nature of them generally have more in common with value firms, with relatively high asset value to market value, than growth stocks. This has been noted in a number of studies, including Chiang & Lee (2002), who found using Style Analysis that EREITs can be classified as a combination of value stocks and t-bills. In addition, the results of Stevenson (2002) in his analysis of volatility spillovers using monthly REIT data would support this view, finding that value stocks were more significant in terms of volatility transference than the large cap S&P500 and NASDAQ or growth indices. The other variables included in the models are the one-month US Treasury Bill and dummy variables for the market crashes of April 2000 and September 2001. The inclusion of these dummy variables allows for the possibility that some form of structural break occurred around these two events for concerning the interaction between REITs and other asset classes.

In relation to the return series' the strong links with small-cap value stocks is clearly demonstrated, with significant findings across all sample periods. However, this is the only variable that provides such consistency of results. Of interest is that in the first sub-period (1992-1996), neither of the large cap indices provide significant findings. In contrast both of the small cap indices are significant at conventional elves as is the Treasury bill series. These findings are in line with the results of studies such as Chiang & Lee (2002). The significance of the growth stock series would perhaps also indicate a general size effect. As one progresses through the time-periods it is evident that the relationship of REITs with the broader equity markets does shift. In particular, the S&P 500 is significant in the second sub-periods, while the relative importance of cash reduces.

{Insert Exhibit 8}

Turning to the volatility model, the GARCH parameters are significant and in line with previous daily studies, with the strong influence of past squared returns and past volatility recorded. For all the time periods, the sum of the volatility parameters implies stationarity due to their summing too less than unity. The volatility dynamics are quite distinct from those reported with respect to the mean equation. In particular two main issues appear to arise out of the results. The first relates to the comparison with the return results. Whereas in relation to Equity REIT returns the influence of the small-cap value sector was consistent across sub-periods this is not the case with regard to volatility, indeed it is only significant in both the final sub-period (2000-2005) and the overall sample. The results highlight the different dynamics that occur with regard to volatility in comparison to returns. In the 1992-1996 period none of the sectors

examined provide significant coefficients with regard to Equity REIT volatility. This to some extent is indicative of the scale and nature of the sector in this period. However, as the REIT market has developed and in particular trading levels increased the impact on volatility fr4om general market sentiment has increased. The first indication of this can be seen in the 1997-2000 period when volatility in the NASDAQ provides a significant influence on the REIT sector. In the final sub-period all of the equity sectors, with the exception of the small-cap growth sector see significant coefficients. This would indicate that the use of daily data provides a contrasting picture compared to the analysis of monthly data and the findings of Stevenson (2002). Monthly data would appear to allow more time for the more substantial and intuitive relationships to come to the fore and particularly in relation to value stocks. However, on a daily basis it would appear that these relationships are less clear and that the markets tend to follow broad sentiment trends with less fundamental relationships at play. Therefore, the inter-relationships between REIT sectors and between them and related sectors, such as value stocks, is to some extent masked at the higher frequency daily data, with the general market being more influential.

The second issue also relates to the dynamics between REITs and value stocks. While it is only significant in one of the three sub-periods, the overall sample also sees a significant coefficient. For the overall period it is also the only equity sector to report such a finding. This possibly implies that the use of shorter sub-periods also highlight instability in the impacts upon REIT volatility with short-term dynamics at play. The longer-term data, in time not data frequency, perhaps does allow this more fundamental relationship to come across.

Conclusion

This paper has examined the dynamics of Equity REITs in the context of univariate GARCH models. The paper has attempted to examine both the causes and properties of volatility in REIT returns. The results highlight the linkages between REITs and mainstream stock indices. The return and volatility findings are in line with previous studies to have examined longer horizons and also provide evidence that GARCH based models are suitable in the analysis of REIT volatility. The use of daily data does provide a number of contrasting volatility spillover findings to those reported by Stevenson (2002) who analyzed the monthly NAREIT indices. In particular it would appear that the more fundamentally based and intuitive results reported in that study are harder to capture when the higher frequency daily data is used. The relationship with value stocks is weakened considerably, while the influence of the large cap sector is enhanced. The exact causes of these diverging results is not however clear. One alternative cause is that the additional

noise contained in daily data results in broad market sentiment playing a more significant role, with the more intuitive and perhaps fundamental relationships being masked at this higher frequency. The second alternative is that we are actually observing a structural change in the relationship between REITs and other sectors due to increased investor awareness and investment in the sector. Given that most previous studies have largely relied on long-term monthly data, the use of this short-term higher frequency data does open up the possibility that such a break has occurred.

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Exhibits

Exhibit 1: REIT and Stock Market Performance 1992-2005

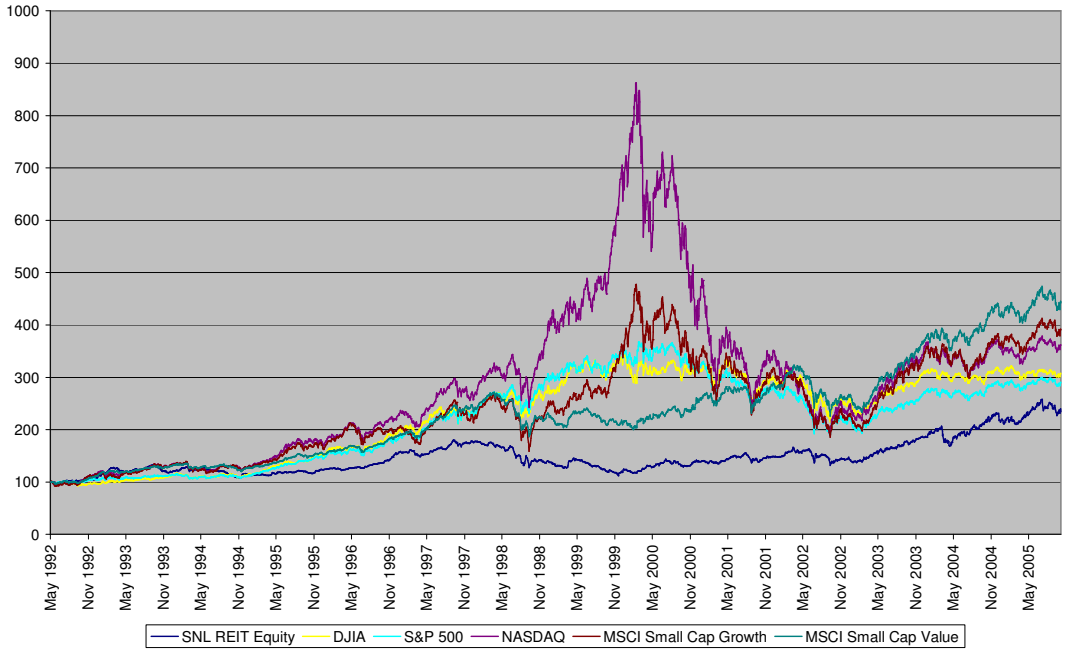

Exhibit 2: Summary Statistics for Daily Equity REIT Returns

	1993-2005	1993-1996	1997-2000	2000-2005
Mean	0.000252	0.000385	-0.000314	0.000472
Median	0.000400	0.000500	-0.000600	0.000800
Maximum	0.045700	0.024100	0.040300	0.045700
Minimum	-0.051000	-0.018400	-0.050400	-0.051000
Standard Deviation	0.007056	0.004073	0.007027	0.008791
Skewness	-0.498722	0.115549	-0.142193	-0.600182
Kurtosis	9.200962	6.746554	11.80262	6.179148
Jarque-Bera	5563.646***	681.6072***	2650.206***	675.5495***

Exhibit 3: Daily Equity REIT Returns

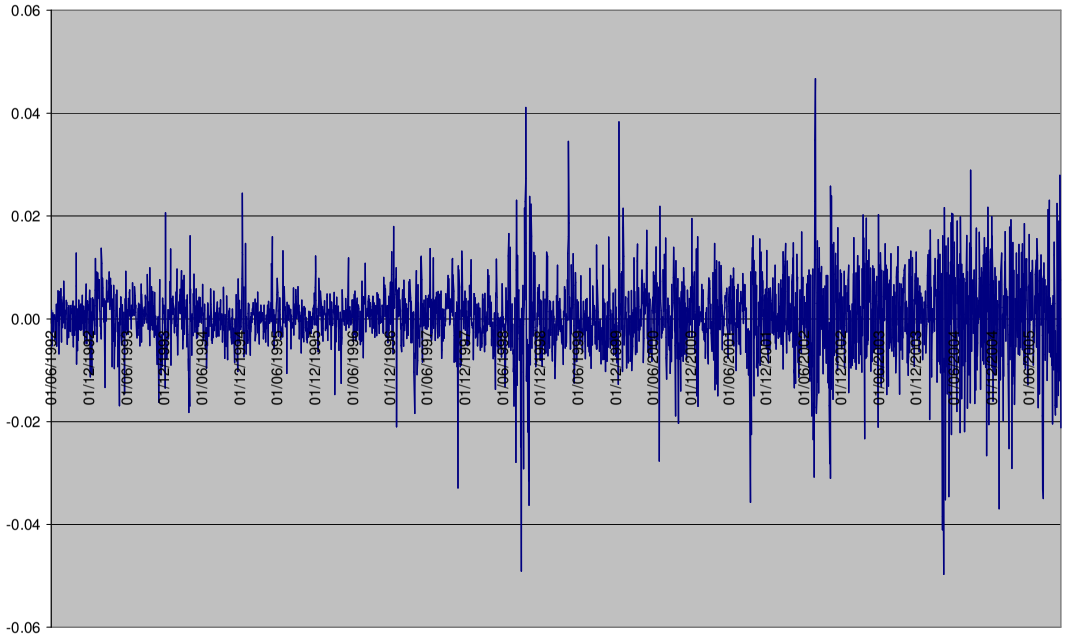

Exhibit 4: Autocorrelation Plots for Daily REIT Returns

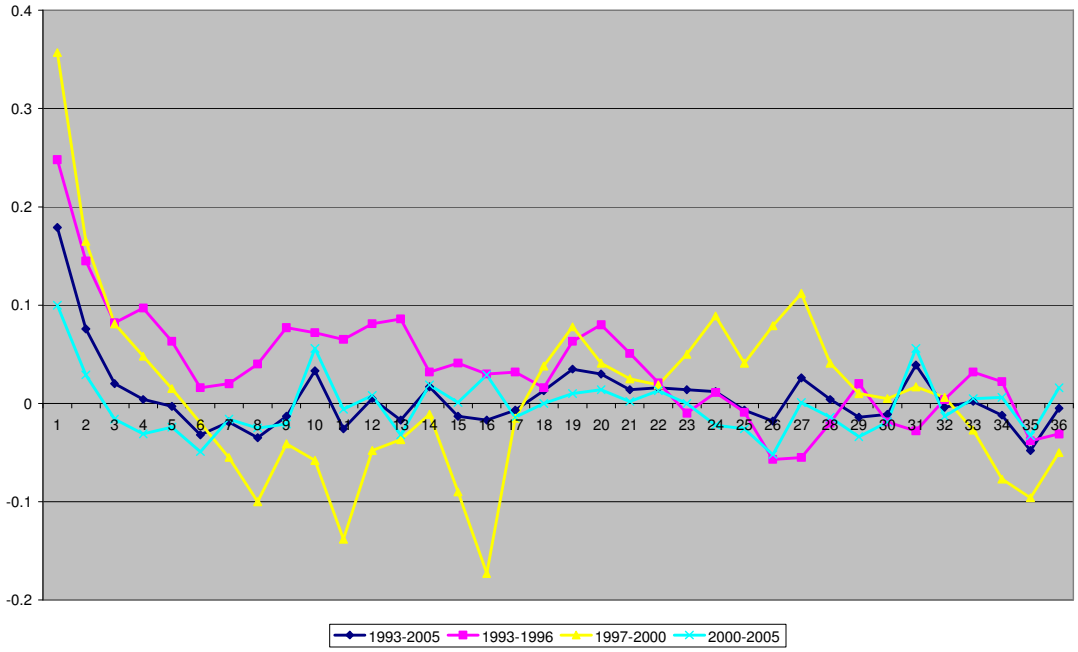

Exhibit 5: Summary Statistics for Daily Equity REIT Volatility

	1993-2005	1993-1996	1997-2000	2000-2005
Mean	4.98E-05	1.67E-05	4.94E-05	7.75E-05
Median	1.09E-05	4.84E-06	1.09E-05	2.60E-05
Maximum	0.002601	0.000581	0.002540	0.002601
Minimum	0.000000	0.000000	0.000000	0.000000
Standard Deviation	0.000142	4.00E-05	0.000162	0.000174
Skewness	8.681430	6.357682	8.596497	6.805121
Kurtosis	109.0633	60.60203	98.93190	68.53133

Exhibit 6: Autocorrelation Plots for Daily REIT Volatility

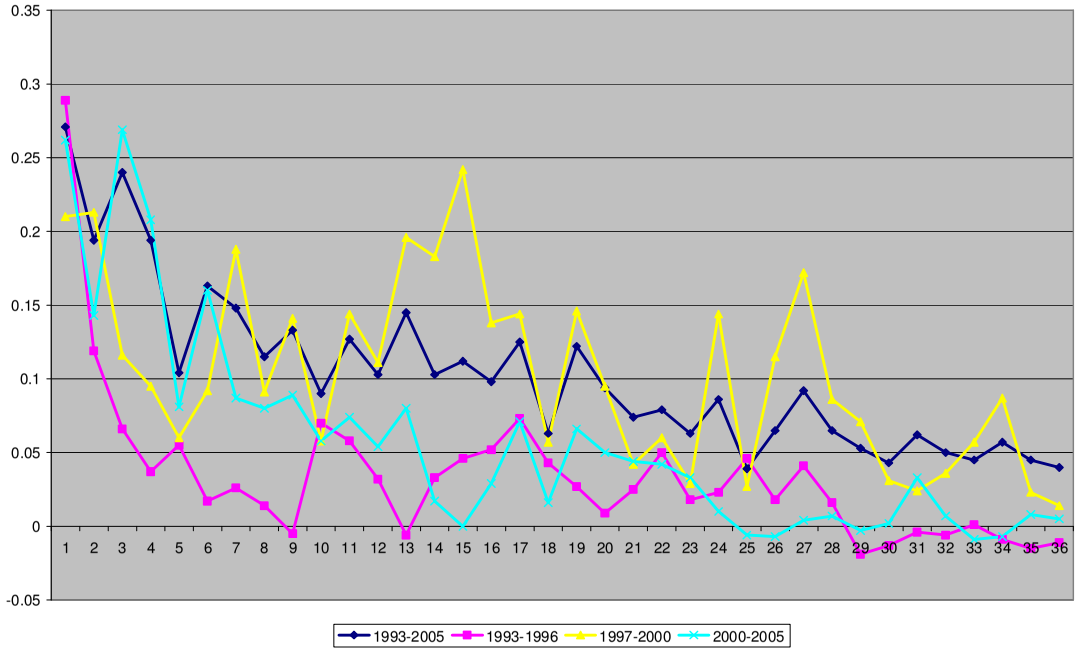

Exhibit 7: Rolling 120 Day REIT Standard Deviations

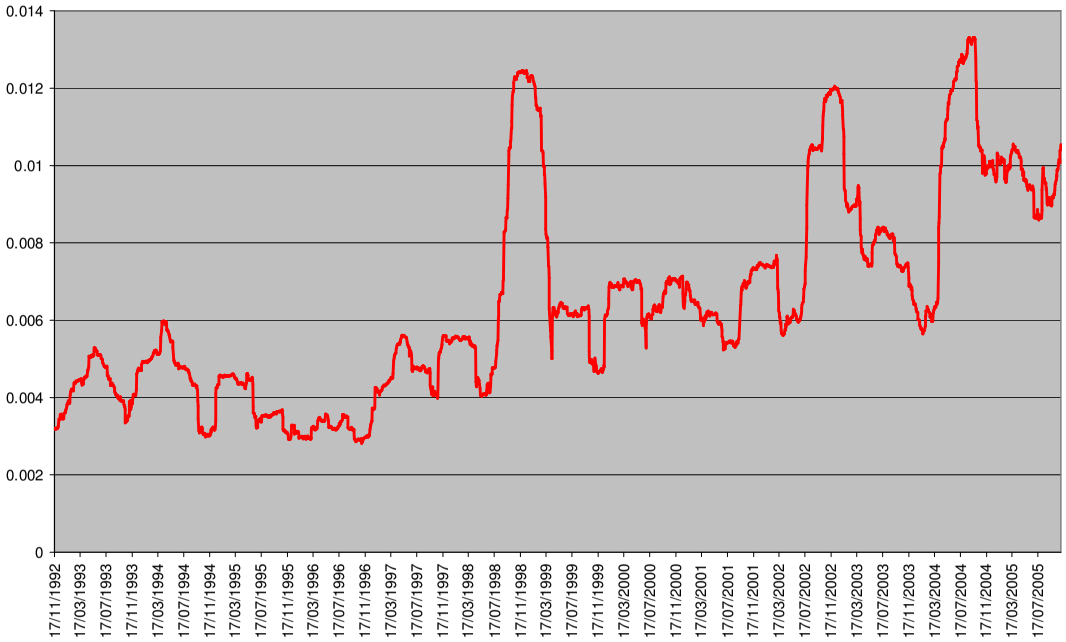

Exhibit 8: Conditional Modeling of Daily Returns Series, GARCH (1,1)

	1992-2005		1992-1996		1997-2000		2000-2005	
	Coefficient	**p-value**	**Coefficient**	**p-value**	**Coefficient**	**p-value**	**Coefficient**	**p-value**
Panel A: Conditional Returns								
Constant	5.99E-05	0.6796	0.0005	0.0228	-0.0008	0.1276	8.90E-05	0.6440
Equity REITs	0.1292	0.0000	0.1223	0.0000	0.2274	0.0000	0.0938	0.0000
S&P500	-0.0693	0.0001	-0.0497	0.1039	-0.0679	0.0117	-0.1817	0.0000
NASDAQ	0.0197	0.1826	0.0205	0.4565	0.0179	0.5466	0.0981	0.0000
S&P Value	0.7857	0.0000	0.7726	0.0000	0.6706	0.0000	0.9740	0.0000
S&P Growth	-0.1449	0.0000	-0.1394	0.0000	-0.0399	0.2642	-0.3052	0.0000
Treasury Bill	-1.2082	0.2846	-4.3092	0.0096	4.2874	0.3549	-1.9113	0.3283
April 2000	0.0017	0.1249	-	-	-	-	0.0018	0.1833
September 2001	0.0011	0.5313	-	-	-	-	0.0004	0.8084
Panel A: Conditional Volatility								
a_1	5.94E-07	0.1679	1.20E-06	0.5737	8.77E-06	0.5604	2.32E-06	0.5175
a_2	0.1168	0.0000	0.1654	0.0010	0.1172	0.0868	0.1167	0.0029
b_1	0.8130	0.0000	0.6365	0.0000	0.2658	0.2062	0.6522	0.0000
S&P500	-0.0029	0.3166	0.0017	0.9249	-0.0676	0.3151	-0.0233	0.0786
NASDAQ	0.0009	0.3401	-0.0047	0.7790	0.0254	0.0861	-0.0063	0.0941
S&P Value	0.0273	0.0007	0.0755	0.2477	0.0983	0.3455	0.0759	0.0558
S&P Growth	-0.0034	0.1714	-0.0056	0.7336	0.0010	0.9851	0.0152	0.1393
Treasury Bill	53.5731	0.9099	-272.7123	0.6821	-813.2713	0.7476	1775.3010	-0.3138
April 2000	6.06E-07	0.8739	-	-	-	-	1.24E-06	0.9136
September 2001	3.08E-06	0.5711	-	-	-	-	1.27E-06	0.8796
Panel C: Diagnostics								
R^2 adj	0.5052		0.4157		0.5853		0.5175	
Q (24)	36.357	0.051	52.960	0.001	26.705	0.318	22.325	0.560
Q^2 (24)	19.787	0.709	47.649	0.003	6.147	1.000	19.177	0.742
ARCH (24)	0.832	0.697	2.095	0.002	0.245	0.999	0.806	0.729

Notes: Results for conditional mean and volatility with explanatory variables are reported as described in text. Marginal significance levels using Bollerslev-Wooldridge standard errors are displayed by parentheses. * denotes significance at the 5% level. Q(24) is a Ljung-Box test on the residual series whereas $Q^2(24)$ is the Ljung-Box test on the squared residuals. ARCH(24) is the Engle (1981) LM test for up to twenty fourth order ARCH.

Endnotes:

[1] The stationarity of the REIT index, and the other equity series used in the main analysis, was tested using the Augmented Dickey Fuller (ADF) unit root test. The findings, which are available from the authors on request, are consistent with past studies modeling equity and REIT series', namely that the price data does not accept the hypothesis of stationarity. Following convention, the price series' are first differenced resulting in stationary series and avoiding avoid spurious conclusions. Further analysis will concentrate on these returns series.