Monetary Shocks and REIT Returns[*]

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Abstract

We examine the influence of US monetary policy on Real Estate Investment Trusts through the examination of changes in the fed funds future rate. This form of analysis allows the isolation of the unanticipated component of Federal Reserve rate changes. In comparison with many previous studies of the REIT sector, the results show a strong response in both the first and second moment of REIT returns to unexpected interest rate movements. Further tests are also conducted in relation to asymmetry in the volatility response and to the calm before the storm effect commonly observed in the broader stock markets. In neither case are supportive results obtained, highlighting differences between the REIT sector and the general equity market.

Monetary Shocks and REIT Returns

1: Introduction

The importance of monetary policy changes and the transmission of information contained therein to asset markets has been the subject of a large number of papers in recent years. This literature has extended from examinations of sensitivity to market interest rates to more detailed examinations of information transfers contained in monetary policy announcements and has examined a wide range of asset classes. This paper examines the impact of changes in the main monetary policy instrument in the United States, the Federal Funds Rate on Real Estate Investment Trusts (REITs). The rationale behind the examination of REITs is due to their unique structure in comparison to mainstream equities. REITs are the primary traded vehicle for real estate investment in the US market. They are structured in a similar fashion to mutual funds and therefore differ from a standard corporate structure due to enhanced tax transparency. In order for a firm to qualify as a REIT the firm is required to have a minimum of 75% of their assets in real estate and to pay out at least 90% of their taxable earnings as dividends. If these requirements are met then the dividend payments of the REIT are exempt from corporation tax[1].

The importance of these requirements and the structure of REITs in comparison to the broader equity markets may lead to a different response in REIT prices to changes in monetary policy. As noted by Bernanke & Kuttner (2005) the impact of rate changes on the general equity market can be viewed as occurring due to three issues. Firstly, the impact on the expected level of future dividends of the firms, secondly, any associated change in the real interest rate used to discount these dividends and thirdly changes in the equity risk premium. Given the characteristics of not only REITs but also the underlying private real estate market a number of aspects of these linkages may taken on additional importance in the context of the traded real estate sector. In relation to the first point the 90% dividend payout requirement will lead to more substantial income flows from REITs than common stocks. However, in addition, the structure of the private real estate market will also lead to an impact. Monetary policy changes will naturally have an influence on general economic activity, which itself will feed through to occupational demand in the underlying real estate market. This will impact upon the rents obtainable by the REIT in their underlying property

portfolio and will thus feed directly through to the dividend payments of the firm. In addition, rate changes will have a further impact on the value of the underlying portfolio. Not only will changes in rental income impact on property values but furthermore, given the linkages between the space and capital markets (DiPasquale & Wheaton, 1992 and Fisher, 1992), there is an impact through property yields (cap rates) on the value of the underlying portfolio. These effects mean that REITs are far more heavily tied to their underlying asset base than both equities generally and also other forms of real estate securities, such as corporate based vehicles in markets such as the UK and Hong Kong. It also means that the response of REITs to changes in monetary policy may differ from the general evidence regarding the stock market.

A further factor that may also lead to differences in the results for REITs in comparison to the overall equity market is the relative size and maturity of the sector. While REITs were established by Congress their growth has largely occurred since the early nineties. In 1991 for example the total market capitalization of the equity REIT sector was according to NAREIT (National Association of Real Estate Investment Trusts) $8,785m. As at the end of 2005 this had increased to over $300bn, while the number of Equity REITs had increased from 86 to 152. Amongst other papers, Cotter & Stevenson (2006) note in their examination of REIT volatility that this growth in the sector has led, particularly in recent years, to changes in the dynamics in the sector. However, while substantial growth has occurred the sector does still comprises of largely small and mid cap firms, with an average size of just under $2bn.

Our methodological approach draws on the recent work of Bomfim (2003), Jones et al. (1998) and Anderson and Bollerslev (1998). The transmission of monetary policy information is assessed through an analysis of meetings of the Federal Open Market Committee (FOMC). As in papers such as Bomfim (2003) we proxy market expectations concerning changes in the Fed Funds Rate through changes in the fed funds futures rate. The current draft of the paper examines three key hypotheses. Firstly we examine the impact of FOMC announcements on both the returns and volatility of the REIT sector. Specifically, by splitting the rate change into its anticipated and unanticipated components the analysis allows an examination of the impact of unexpected rate changes. Secondly, we test for asymmetry in the response.

Finally, a specific aspect of REIT volatility around the time of FOMC meetings is considered and we investigate what is commonly referred to as the *calm before the storm* effect. This refers to the fact that volatility tends to fall immediately prior to an announcement. This effect has been noted by Jones et al. (1998), Li & Engle (1998) and Bomfim (2003) for the Treasury Bond, Treasury Bill and Stock markets respectively.

The remainder of the paper is laid out as follows. The following section briefly reviews the existing literature to have examined both the specific response of REITs to interest rate movements and also the broader literature to have investigated interest rate sensitivity of assets and the transmission of monetary information. Section 3 details the methodological approach and the data requirements. Section 4 contains the main empirical findings and the concluding comments are provided in the final section.

2: Literature Review

The majority of empirical studies to have analyzed the relationship between REITs and interest rates have relied upon examining the relationship with market rates, with no accounting for the degree to which the change in rates in anticipated[2]. In addition, much of this literature has tended to examine the issue in the context of asset pricing and the determinants of REIT returns. A number of papers have shown that the sensitivity of REITs to interest rates is both time-varying and also dependent on the rate used. Both Chen & Tzang (1988) and Liang et al. (1995) find evidence of instability in their findings dependent on the exact time period examined. This is evidence that is supported by Devaney (2001) and He et al. (2003). He et al. (2003) highlight the importance of proxies by illustrating the sensitivity of the results according to the interest rate proxy used. The authors also find further evidence concerning the time-varying nature of the linkages between interest rates and real estate securities. Using a Flexible Least Squares approach the paper highlights that all of the proxies tested have time-varying characteristics. In addition, the authors confirm previous findings showing that REITs are most sensitive to changes in long-term yields and low-grade corporate bonds although, as with other proxies used, these

findings are also time-varying. This is a finding that is consistent with the literature to have examined financial institutions (e.g. Kane & Unal, 1988).

Devaney (2001) utilizes a GARCH-M model similar to that used in the broader interest rate sensitivity literature such as Elyasiani & Mansur (1998). This is one of the few papers to have extended the analysis to examine the impact of interest rates on REIT volatility. The results illustrate the difference in focus between the Equity and Mortgage REIT sub-sectors. While highly significant findings are reported with regard to the mortgage sector in the case of Equity REITs while the coefficients may be of the expected sign they are generally insignificant. It should be noted however that Devaney (2001) analyzed monthly data. A recent paper by Cotter & Stevenson (2006) examines daily REIT volatility. While the focus of that paper is not concerned with interest rate sensitivity, Treasury Bills are incorporated into the multivariate GARCH model used to examine the underlying volatility dynamics of REITs. The results show that Treasury Bill movements are significant in terms of both returns and volatility for Equity REITs.

Most of the existing work on REITs' relationship and interactions with interest rates has broadly followed the standard methodological approaches adopted in the broader financial economics literature. This traditionally concentrated upon the pure market sensitivity of stocks to market interest rate movements. An important issue arising from this early literature and of relevance in the context of the current study is the base issue that interest rate risk is priced[3]. In addition, a number of papers have reported on empirical evidence illustrating the time-varying nature of the sensitivity. Yourougou (1990) compares periods of relative stability and volatility in interest rates, finding that during periods of relative interest rate stability stocks do not display significant sensitivity. The stability of rate movements is linked to the extent to which the rate changed is anticipated. If rates are relatively stable then even if movements are not anticipated they will generally be of a smaller magnitude. However, during periods of enhanced volatility in interest rates there will be greater uncertainty concerning rate movements and also in all likelihood the magnitude of them. In comparison to his results during periods of stability, Yourougou (1990) finds that during periods of relative volatility bank stocks in particular do react significantly to interest rate movements. Supporting evidence is also reported by Kwan (1991) who

finds that bank stocks are influenced by unanticipated shocks to rates. A number of papers in the mid-to-late nineties extend this issue by not only examining the linkages in the first moment of both interest rates and stock returns, but also by looking at the respective second moments. Flannery et al. (1997) report that conditional interest rate volatility is a significant influence. Elyasiani & Mansur (1998) utilized a GARCH-M model on a sample of monthly returns for 56 US banks. The results show that both the level and volatility of interest rates significantly impact the first and second moments of bank stocks.

As the focus of the current paper is not on market rate movements but rather analyses official rate changes and the decisions of the FOMC, the analysis also links in with the broader literature to have looked into the impact of macroeconomic variables on equity markets. Flannery & Protopapadkis (2002) examine the effect of announcements concerning 17 macroeconomic series. Of the 17 series the authors find evidence that six (CPI, PPI, a monetary aggregate, balance of trade, employment and housing starts) are priced. However, only unanticipated money supply announcements influence both the first and second moment of stock returns. Connolly & Wang (2003) examine the impact of monetary announcements in an international environment looking at the US, UK and Japan[4]. One interesting result from this study is evidence supportive of an asymmetric response in terms of whether the announcement contained good or bad news. This is a similar finding to that reported by Bomfim (2003) and is consistent with the leverage effect noted by Black (1976).

A large literature has examined the specific impact of US monetary policy on the equity markets[5]. An important issue in any examination of rate changes by the Federal Reserve is that of technical and non-technical rate changes. Prior to 1979 the Federal Reserve effectively changed the discount rate to bring it into line with market rates[6]. Both Smirlock & Yawitz (1985) and Pearce & Roley (1985) provide evidence on the impact of rate changes on the stock market. Pearce & Roley (1985) is one of the first studies to split the rate change into its expected and unexpected component, in this case through the use of survey data. Post 1979 and the change in rate change policy the authors show that stock prices react significantly to unanticipated changes in the discount rate. Jensen & Johnson (1995) and Jensen et al. (1996) illustrate the wider impact of changes in rate changes. They find that changes in the discount rate

effectively send signals concerning monetary policy. A further change in the operation of the Federal Reserve occurred in 1994. Prior to February 1994 the Federal Reserve would effectively release information on rate changes the day after a FOMC meeting through the Open Market Desk. However, after this date rate changes have been publicly announced directly after each FOMC meeting.

Thorbecke (1997) provides empirical evidence concerning the influence of monetary policy on stocks. The paper utilizes the Federal Funds Rate and non-borrowed reserves. While the general results highlight that an expansionary monetary policy increases ex-post returns, an interesting element of the analysis is that asymmetries in the responses may also help to explain the findings of Fama & French (1995). The authors find that monetary shocks affect smaller firms to a greater extent than large firms. It is hypothesized that this is due to the impact on credit availability noted by Gertler & Gilchrist (1994). Given the relative size of REITs it may therefore be expected that this would lead to an enhanced sensitivity in comparison to the overall market. However, it should be remembered that the tax status of REITs does also bring into question the tax advantages of debt issuance.

Kuttner (2001) assesses the influence and impact of policy based rate changes by the Federal Reserve on market rates. Market rates are proxied by Treasury bill, note and bond yields. The results highlight the importance of decomposing expected and unexpected components of monetary policy changes. While expected rate changes are not statistically significant, unexpected rate changes result in a large and significant response in market rates. Patelis (1997) note that monetary policy changes can also provide valuable predictive information on future stock market movements. Furthermore, Rigobon & Sack (2003) find that the relationship between interest rates and stock prices is a bilateral one, reporting evidence that stock market behavior influences future interest rate movements. A recent paper by Bernanke & Kuttner (2005) adopts both an event study methodology and a VAR model of the type proposed by Campbell (1991). The event study results show a significant response to unanticipated changes in the rate. The VAR analysis finds that the primary impact of rate changes onto prices is derived from their impact on expected future excess returns[7].

In specific relation to the empirical tests run in the current study Jones et al. (1998) were one of the first to provide evidence on the *calm before the storm* effect. The paper examines the impact of employment and PPI announcements on bond returns. They also examine what may cause volatility persistence. They find no evidence of persistence in volatility following a monetary announcement, concluding instead that volatility persistence may be a result of the clustering of news announcements. Using the Mitchell & Mulherin (1994) database of news events they illustrate that information announcements are positively autocorrelated at significant levels at a daily interval[8].

Bomfim (2003) examines the S&P 500 Composite and its response to Fed Funds Rate changes. The author initially finds no evidence of the *calm before the storm* effect. While volatility is higher on the day of the announcement, there is no reduction in volatility in the day prior to the FOMC meeting. However, the sample examined in this paper extends back to 1989 and therefore pre-dates the change in Federal Reserve policy. As noted by Bomfim (2003) between 1989-February 1994 only 24% of rate changes were taken at scheduled meetings of the FOMC. However, since the policy change in 1994 the vast majority of rate changes have coincided with FOMC meetings. In his sample, running through to 1998, 85% of all rate changes occurred and were announced on meeting days. Therefore, the importance of the FOMC meetings and the anticipation of the markets to them may have increased since February 1994. Once this potential shift in the importance of FOMC meetings to the markets in accounted for through the use of a dummy indicating post 1994 rate changes there is significant evidence of a *calm before the storm* effect. One further result in the paper is that with regard to asymmetry no significance evidence is reported with regard to returns but there is in relation to stock market volatility.

3: Data and Methodological Framework

Our methodology draws on the recent work of Bomfim (2003), Jones et al. (1998) and Anderson and Bollerslev (1998). Firstly, we examine the impact of FOMC announcements on both the returns and volatility of the REIT sector. Specifically, by splitting the rate change into its anticipated and unanticipated components the analysis allows an examination of the impact of unexpected rate changes. Secondly, the

behaviour of REITs returns around the time of FOMC meetings is considered and we investigate the *calm before the storm* effect.

The data is this paper is daily and extends from 31st January 1996 through to March 1st 2005. A potential issue with the use of daily data is that it may mask the exact impact. In particular, it is hard to isolate the impact of Federal Funds Rate changes as other announcements may be made that day. However, as Bomfim (2003) notes, FOMC meetings do not systematically coincide with any one economic date release. The REIT market is proxied by the Dow Jones-Wilshire Equity REIT Index. As noted in the introduction, this paper solely examines the Equity REIT sector and does not examine, either in aggregate or in isolation, the Mortgage REIT sector.

The change in the Federal Funds Target Rate was obtained from the Federal Reserve Board of Governors. The proxy used for the unanticipated change in the target rate is the 1-day change in the price of the 1-month ahead 30-day Federal Funds Futures contract traded on the Chicago Board of Trade (CBOT). Previous papers to have utilized such a proxy for monetary policy changes include: Bomfim & Reinhart (2000), Kuttner (2001), Poole & Rasche (2000), Reinhart & Simin (1997), Roley & Sellon (1998) and Thornton (1998). Previous empirical work in the field such as Connolly & Wang (2003), Flannary & Protopapadkis (2002) and Li & Engle (1998) use alternative measures of expectations. These alternatives include the growth rate of money supply and survey data, however, Gurkaynak et al. (2002) show that the fed funds futures contract provides the best available forecast of the Feds Fund Rate.

The modeling approach used is based on that used by Bomfim (2003) and also Jones et al. (1998). The GARCH model can be specified as follows:

$$REIT_t = \beta_0 + \beta_1 \Delta FFF_t + \beta_2 REIT_{t-1} + \beta_3 SP_t + \beta_4 Mon + \beta_5 Tue + \beta_6 Thu + \beta_7 Fri + \mu_t \quad (1)$$

$$\mu_t = e_t \sqrt{s_t} \quad (2)$$

$$e_t = \upsilon_t \sqrt{h_t} \quad (3)$$

$$E\left(e_t \middle| \Omega_{t-1}\right) = 0$$
$$E\left(e_t^2 \middle| \Omega_{t-1}\right) = h_t \quad (4)$$
$$E\left(u_t^2 \middle| \Omega_{t-1}\right) = s_t h_t$$

$$h_t = \alpha_0 + \alpha_1 h_{t-1} + \alpha_2 e_{t-1}^2 \quad (5)$$

The REIT series is the dependent variable in the conditional mean equation. The independent variables comprise of the 1-day change in the fed funds futures (*FFF*), the lagged one-day REIT return and the S&P 500. Dummy variables for days of the week are also incorporated into the specification. The unexplained component (μ_{t+1}) comprises of a non-normal stochastic element (e_{t+1}) whose conditional variance is time-varying and a dummy variable (s_{t+1}). The dummy indicates the impact of particular day effects and can be expressed as:

$$s_t = 1 + \delta_0 I_t^{(F)} + \delta_1 I_{t-1}^{(F)} + \delta_2 I_{t+1}^{(F)} + \delta_3 \text{Mon} + \delta_4 \text{Tue} + \delta_5 \text{Thu} + \delta_6 \text{Fri} + \phi \Delta FFF_t \quad (6)$$

Where $I_t^{(F)}$ is a dummy set to unity when there is FOMC meeting and zero otherwise. The model is estimated using the quasi maximum likelihood procedure proposed by Bollerslev & Wooldridge (1992).

As previously mentioned, three key hypotheses are tested. The first hypothesis relates to a news effect and whether an unanticipated change in the fed funds rate has any effect on the REIT sector. This is examined through the conditional mean equation. The hypothesis would be supported if β_1 is negative and statistically significant. We also address whether the shock to monetary policy has any effect on the second moments, which would be highlighted by the statistical significance of ϕ in Equation (6). The possibility that there may be an asymmetric volatility effect (that higher than expected changes in rates will lead to great volatility) will also be considered. The final hypothesis relates to the *calm before the storm* effect. This refers to a hypothesized lower level of volatility on the day before FOMC meetings and higher on the day of the announcement itself. This is tested based the results from Equation (6). The hypothesis is confirmed if coefficient δ_0 is positive and significant and δ_1 is negative and significant at conventional levels.

4: Empirical Evidence

The model is estimated under a variety of different scenarios. The initial examination concentrates upon changes in the Fed Fund Futures on FOMC meeting days. We then extend this to also incorporate unscheduled rate changes that take place outside of scheduled FOMC meetings[9]. The initial analysis is reported in Table 1. From these results it can be seen that the change in Fed Funds Futures impacts significantly on both the mean and volatility of the Equity REIT sector. Furthermore, the sign of the coefficient in relation to the mean equation is of the anticipated negative sign. This alone is interesting given the frequent lack of consistent findings in previous studies of REIT sensitivity to interest rate movements. The Devaney (2001) paper adopts the most similar methodological approach, in that a GARCH based model, in this case a GARCH-in-Mean specification, is used. However, the analysis on market rates generally finds an insignificant response in either the mean or variance equations. Only when the Mortgage REIT sector is examined are significant coefficients reported. This divergence in findings highlights the importance of taking into account market expectations and incorporating into the model specification the unanticipated nature of the rate change. In addition, it should also be reiterated that the Devaney (2001) paper examined monthly not daily data[10]. As would also be expected, the coefficients relating to the lagged REIT sector and the market index, as proxied by the S&P 500, are positive and significant at conventional levels. They are also evidence of GARCH effects in the model, justifying the use of this form of specification. One issue relating to the day of the week dummies that deserves noting is that in both the mean and variance equations the coefficients referring to Friday are positively signed and significant at conventional levels. This indicates a Friday effect in both the first and second moments of daily REIT index data.

The second hypothesis is concerned with the extent to which the markets take into account the unexpected element of the rate change. This is captured through the ϕ coefficient in the variance equation. A non-zero coefficient would imply that the markets hadn't fully anticipated the rate change announced at the FOMC meeting. The results show a positive and significant coefficient. This would indicate that not only had the markets not fully captured in their expectations the rate change but that the unanticipated and unaccounted for component of the change imparts new

information to the market that has a subsequent impact upon the volatility of the REIT sector.

The final issue relates to the hypothesized *calm before the storm*. As noted, this is tested through the examination of coefficients δ_0 and δ_1 in the variance equation. Unlike previous empirical evidence such as Bomfim (2003) we find no evidence of such an effect. For the hypothesis to be supported δ_0 should be positive and significant and δ_1 negative and significant. The results show that neither coefficient is significant, and furthermore, δ_0 is of the unanticipated sign, being negative. This is an issue that future research may wish to examine in further depth given that δ_2 which relates to the day after the announcement is positive. While little can be conclusively drawn from these findings given the lack of significance in any of the relevant coefficients, it would imply some form of lagged *calm before the storm* effect, with a reduced level of volatility, increasing post-announcement. It is possible that non-synchronous and thin trading leads to a lagging effect in the Wilshire REIT index thereby contributing to these findings. As noted previously, despite the increase in both the size of the REIT sector and the corresponding increase in trading volume in recent years, the sector is relatively small. While the average market cap in the sector was just under $2bn as of the end of 2005, 46% of the firms had a market value less than $1bn. The use of individual REIT returns and the separate examination of REITs of differing levels of both market value and trading volume may produce more conclusive findings in this regard. In comparison to the findings of Bomfim (2003) in relation to the S&P 500, it should be emphasized that his initial lack of significant evidence was in relation to the sample pre-dating the change in Fed policy in 1994. Once this was accounted for in the analysis significant results were reported. As our sample dates only from 1996 the change in policy can not be a possible reason behind the lack of significant evidence.

The analysis contained in Table 1 is solely concerned with rate changes announced at scheduled meetings of the FOMC. In order to consider the sensitivity of our results we investigate the impact of rate changes on all announcement days, both scheduled and unscheduled. While the number of unscheduled announcements has fallen dramatically in recent years it is still an important issue to consider. This is

particularly the case for the events of 2001. During the first half of 2001 there were two unscheduled rate changes (interest rate reductions), 3rd January and 18th April. These two particular unscheduled rate changes are noteworthy given the Fed's preference for scheduled rate changes in recent years and the fact that they were both 50 basis point reductions. In addition, the impact of 9/11 was also a major factor on the markets interest rate expectations and the actions of the Federal Reserve. For this reason, we extend the analysis, as reported in Table 2, to include rate changes that occurred outside of the auspices of a FOMC meeting.[11] There are relatively few changes in the results after the extension of the analysis. As with the original specification, GARCH effects are evident, there is the anticipated influence of both lagged REIT returns and the contemporaneous S&P 500 in the mean equation and evidence of a Friday effect on both returns and volatility. In addition, as with the results previously discussed there is no significant evidence of a *calm before the storm effect*. Finally, there is evidence that there is a significant response to the unanticipated component of the rate change in terms of both the mean and variance equation.

The final part of the analysis extends the examination looking at the impact of the surprise element on volatility to assess whether there is evidence of an asymmetrical response. This analysis is based on the leverage effect noted by Black (1976) and the volatility feedback hypothesis of French et al. (1989). This has been supported empirically in papers such as French et al. (1989) and Nelson (1991) while asymmetry has also been reported in papers closely related to the current study such as Bomfim (2003) and Connolly & Wang (1998). To examine this issue the variance equation is adjusted to form the following specification.

$$s_t = 1 + \delta_1 I_{t-1}^{(SA)} + \delta_2 I_{t+1}^{(SA)} + \delta_3 \text{Mon} + \delta_4 \text{Tue} + \delta_5 \text{Thu} + \delta_6 \text{Fri} + \phi_1 \Delta FFF_t^{+} + \phi_2 \Delta FFF_t^{-} \quad (7)$$

Where positive and negative unexpected changes in the fed funds futures rate are separated. The results, contained in Table 3, are quite contrary to the existing empirical evidence. The existing evidence has largely found evidence of an asymmetrical response, with an enhanced rise in volatility following a negative shock,

i.e. a higher than anticipated rise in rates, in comparison to positive shocks. However, in the case of REITs both coefficients are of the same sign and differ from each other to an insignificant degree, with a p-value from the Wald statistic of 0.23. Two possible reasons behind the lack of asymmetry are firstly level of trading in the sector and secondly the more explicit link of interest rates to both the value of the underlying property portfolio and the resulting cash flows.

5: Conclusions

This paper has extended the analysis of the sensitivity of REITs to changes in interest rates in a number of respects. Firstly, it has, through the use of the fed funds futures, separated out rate changes into their expected and unexpected components allowing a more in-depth analysis of the efficiency of the markets and also a more accurate examination of how the markets respond to rate changes. Secondly, it has examined has specifically tested for both asymmetric responses in volatility to interest rate movements and the *calm before the storm* effect. The analysis provides interesting results. In comparison to previous studies of REIT interest rate sensitivity the main results do show significant responses in both returns and volatility to unanticipated rate changes. The separation of rate changes into their anticipated and unanticipated component is the most probably reason behind the divergence in these findings in comparison to those previously reported. However, the results relating to asymmetry and the *calm before the storm* are in marked contrast to studies of the broader capital markets. No evidence is found in either case. It is possible that in relation to the *calm before the storm* this is due to the effect of non-synchronous and thin trading within the REIT sector, resulting in a lagged effect. There is some, though insignificant, evidence of a lagged effect, which would be consistent with non-synchronous trading.

It is intended that future drafts of the paper extend on the analysis in a number of respects. Firstly, it is intended that a more detailed examination of the findings with regard to the lack of a *calm before the storm* effect and asymmetry is undertaken. As previous noted a possible cause behind both results is the relative size of the sector. It is therefore intended that tests be undertaken based on portfolios based on market capitalization. In addition, it is also intended that the results be extended to examine Mortgage REITs. Given their different focus and the differences in the underlying

assets, not only will in all probability will there be divergences in the results, but the link with the underlying assets of Equity REITs may aid in the explanation behind the results with regard to asymmetry.

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Tables

Table 1: Impact of US Monetary Policy Shocks on the Mean & Volatility of REIT's (Scheduled Announcements)

$$REIT_t = \beta_0 + \beta_1 \Delta FFF_t + \beta_2 REIT_{t-1} + \beta_3 S\&P_t + \beta_4 \text{Mon} + \beta_5 \text{Tue} + \beta_6 \text{Thu} + \beta_7 \text{Fri}$$

$$h_t = \alpha_0 + \alpha_1 h_{t-1} + \alpha_2 e^2_{t-1}$$

$$s_t = 1 + \delta_0 I_t^{(SA)} + \delta_1 I_{t-1}^{(SA)} + \delta_2 I_{t+1}^{(SA)} + \delta_3 \text{Mon} + \delta_4 \text{Tue} + \delta_5 \text{Thu} + \delta_6 \text{Fri} + \phi \Delta FFF_t$$

Variable	Coefficient	t-statistic
Panel A: Mean Equation		
β_0	-0.03	-1.21
β_1	-0.84*	-10.30
β_2	0.18*	9.80
β_3	0.24*	28.70
β_4	0.05	1.55
β_5	0.09*	3.12
β_6	0.05	1.54
β_7	0.11*	3.37
Panel B: Variance Equation		
α_0	0.01*	4.92
α_1	0.13*	9.06
α_2	0.80*	14.81
δ_0	-0.40	-1.25
δ_1	-0.01	-0.07
δ_2	0.36	1.45
δ_3	0.10	1.21
δ_4	-0.13	-1.07
δ_5	0.10	0.85
δ_6	0.22*	2.35
ϕ	0.47*	2.04

Using one day change in 1 month ahead federal funds future contract as unanticipated change. The t statistics are robust using the procedure from Bollerslev & Wooldridge (1992). * indicates statistical significance.

Table 2: Impact of US Monetary Policy Shocks on the Mean & Volatility of REIT's (Total Announcements)

$$REIT_t = \beta_0 + \beta_1 \Delta FFF_t + \beta_2 REIT_{t-1} + \beta_3 S\&P_t + \beta_4 \text{Mon} + \beta_5 \text{Tue} + \beta_6 \text{Thu} + \beta_7 \text{Fri} + \beta_8 2001$$

$$h_t = \alpha_0 + \alpha_1 h_{t-1} + \alpha_2 e^2_{t-1}$$

$$s_t = 1 + \delta_0 I_t^{(TA)} + \delta_1 I_{t-1}^{(TA)} + \delta_2 I_{t+1}^{(TA)} + \delta_3 \text{Mon} + \delta_4 \text{Tue} + \delta_5 \text{Thu} + \delta_6 \text{Fri} + \delta_7 2001 + \phi \Delta FFF_t$$

Variable	Coefficient	t-statistic
Panel A: Mean Equation		
β_0	-0.03	-1.27
β_1	-0.72*	-5.02
β_2	0.18*	9.89
β_3	0.24*	28.76
β_4	0.05	1.53
β_5	0.09*	3.10
β_6	0.05	1.53
β_7	0.11*	3.35
β_8	0.02	0.54
Panel B: Variance Equation		
α_0	0.01*	4.78
α_1	0.13*	9.05
α_2	0.80*	14.70
δ_0	0.31	1.14
δ_1	-0.02	-0.12
δ_2	-0.25	-1.19
δ_3	0.09	1.05
δ_4	-0.13	-1.06
δ_5	0.11	0.92
δ_6	0.23*	2.36
δ_7	0.01	0.23
ϕ	0.57*	2.01

Using one day change in 1 month ahead federal funds future contract as unanticipated change. The t statistics are robust using the procedure from Bollerslev & Wooldridge (1992). * indicates statistical significance.

Table 3: Impact of US Monetary Policy Shocks on the Mean & Volatility of REIT's (Scheduled Announcements)

$$REIT_t = \beta_0 + \beta_1 \Delta FFF_t + \beta_2 REIT_{t-1} + \beta_3 S\&P_t + \beta_4 \text{Mon} + \beta_5 \text{Tue} + \beta_6 \text{Thu} + \beta_7 \text{Fri}$$

$$h_t = \alpha_0 + \alpha_1 h_{t-1} + \alpha_2 e_{t-1}^2$$

$$s_t = 1 + \delta_1 I_{t-1}^{(SA)} + \delta_2 I_{t+1}^{(SA)} + \delta_3 \text{Mon} + \delta_4 \text{Tue} + \delta_5 \text{Thu} + \delta_6 \text{Fri} + \phi_1 \Delta FFF_t^+ + \phi_2 \Delta FFF_t^-$$

Variable	Coefficient	t-statistic
Panel A: Mean Equation		
β_0	-0.02	-1.05
β_1	-0.84*	-7.83
β_2	0.18*	9.80
β_3	0.24*	28.62
β_4	0.05	1.54
β_5	0.09*	3.15
β_6	0.05	1.59
β_7	0.11*	3.37
Panel B: Variance Equation		
α_0	0.01*	4.73
α_1	0.13*	9.06
α_2	0.81*	15.14
δ_1	-0.12	-0.73
δ_2	0.28	1.26
δ_3	0.10	1.18
δ_4	-0.12	-1.05
δ_5	0.09	0.81
δ_6	0.22*	2.29
ϕ_1	-0.48	-1.35
ϕ_2	-0.07	-0.25
Hypothesis Test (p-values for Wald Statistic)	$\phi_1=\phi_2=0$	0.23

Using one day change in 1 month ahead federal funds future contract as unanticipated change. The t statistics are robust using the procedure from Bollerslev & Wooldridge (1992). * indicates statistical significance.

Endnotes:

[1] In addition to what are commonly referred to as Equity REITs there are also Mortgage REITs. These vehicles invest in real estate based debt rather than in the underlying property market. The 75% of asset and 90% of taxable income rules also apply to Mortgage REITs. In the current paper only Equity REITs are examined. It is intended that future drafts of the paper extend the analysis to the mortgage sector.

[2] See Allen et al. (2000), Chen et al. (1997), Chen & Tzang (1988), Devaney (2001), Liang & Webb (1995), Ling & Naranjo (1997), McCue & Kling (1994), Mueller & Pauley (1995) and Swanson et al. (2002).

[3] See Stone (1974), Lynge & Zumwalt (1980), Sweeney & Warga (1986), Scott & Peterson (1986) and Bae (1990).

[4] Conover et al. (1999) also note the importance and influence of US monetary policy in an international context, while Lastrapes (1998) provides further international empirical evidence on the influence of monetary policy on equity markets.

[5] An early paper to examine this is Waud (1970).

[6] Roley & Troll (1984), Cook & Haen (1988) and Duecker (1992) examine the issue of technical and non-technical rate changes in the context of the impact of policy rate changes on market interest rates.

[7] Further papers to have examined issues concerned with macroeconomic data and stock movements include Berry & Howe (1994), Mitchell & Mulherin (1994), Ederington & Lee (1993), Cutler et al., (1989) and Roll (1988).

[8] Castanias (1979) provides an early study on the volatility of the markets surrounding the release of economic data.

[9] Note that given the data period examined (1996-2005), it is not necessary to take into account the change in the operations of the Federal Reserve in 1994.

[10] The importance of the frequency is also highlight in a recent working paper by Stevenson et al. (2005) who examine property companies in the UK in a similar GARCH-M framework. They do find evidence of significant interest rate sensitivity in the UK market at a daily frequency. However, differences in the structure of real estate vehicles between the UK and US do make a direct comparison of findings difficult.

[11] Given the events of the first nine months of 2001, the unusually large changes in monetary policy and the terrorist attacks, we also incorporate a dummy variable into both the mean and variance equations. As can be seen from Table 2, the dummy variable is not statistically significant.