On the Interest Rate Sensitivity of REITs: Evidence from Twenty Years of Daily Data

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Executive Summary

This study evaluates interest rate sensitivity for equity REITs using a multi-factor asset pricing model estimated with daily data. We utilize yield changes and, as an alternative, bond betas, to measure REITs' sensitivity to interest rate shifts. We find that the degree of interest rate sensitivity varies over time, has switched direction and that any "pure" effect is often subsumed in equity REITs beta against stocks. Despite recent high sensitivity, we conclude that there is no long-run predictive rule that applies to how equity REIT returns respond to movements in interest rates.

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The 1991 initial public offering (IPO) of Kimco Realty is often taken as the starting date of the "modern era" for publicly traded real estate investment trusts (REITs). Investors' speculations and debates about how changing interest rates affect REIT share prices predate Kimco's IPO, continued during the 1990s wave of REIT offerings and are ongoing. In this article we provide empirical evidence on the topic. Our study builds on and extends Shulman (2015), which found a high degree of interest rate sensitivity for equity REITS during 2013 and 2014. We use a formal model to measure interest rate sensitivity from 1995 through early 2016, a time period that covers several economic, capital and real estate market cycles.

Investors, of course, expect that changes in yields on risk-free securities, such as U.S. Treasury issues, affect valuations of most investments. For example, the value of a U.S. Treasury bond, which makes pre-specified payments on a known schedule, is determined by its yield, so a change in its required yield will explain nearly all its price change over a short interval. However, a bond with identical expected payments but subject to credit risk may experience a larger or smaller change in price, depending on how much its credit spread changes.[1] Equities, including REITs, should, in principle, be affected by changing required yields on risk-free investments. Of course, other factors might affect equity prices at the same time.

Some investors conjecture that REIT values and returns might exhibit a higher degree of interest rate sensitivity than the average stock because:

1) Equity REITs values in large part reflect holdings of long-lived tangible assets, which are bought and sold in a large and fairly observable market.
2) REIT assets are more capital intensive than those held by the average public company.
3) REITs are more highly leveraged in that their debt level typically ranges from five to ten times EBITDA, compared to three times EBITDA for the average investment-grade industrial company.

4) REITs typically offer dividend yields notably higher than the average publicly traded stock. As a result, REITs often appeal to income-oriented investors who might "chase yield."

Our analysis is intentionally limited. We do not seek to examine REIT returns in a broad asset pricing framework or a general equilibrium theory that simultaneously values other asset classes such a bonds, non-REIT stocks and direct or private-market real estate. Our focus is interest rate sensitivity; however, as we discuss below, we believe it is relevant to include the effects of factors beyond pure interest-rate changes in seeking to assess sensitivity.

I. Literature Review

Shulman (2015), mentioned previously, found a high degree of interest rate sensitivity for equity REITS in 2013 and 2014, using daily data. His study examined variability in the performance of the price-only version of the MSCI REIT Index relative to Standard and Poor's 500 Index as a function of the ten-year U.S. Treasury note yield.

Other than Shulman (2015), we found that there has been little detailed empirical work focusing on the interest rate sensitivity of REITs in over a decade. Glasscock, Lu and So (2000) found that REIT returns were most sensitive to returns on small cap stocks. Swanson, Theis and Casey (2002) found that REITs were more sensitive to the term structure of interest rates than to the level of interest rates. Hee, Webb and Mayer (2003) observed that REIT returns were more sensitive to changes in Baa yields than to changes in yields on U.S. Treasuries.

Clayton and MacKinnon (2001) examined the time-varying nature of the relationship between equity REIT returns and returns on financial assets, including bonds. Although their paper does not focus on interest rates *per se*, interest rate changes obviously were a factor in bond returns. One of the contributions of Clayton and MacKinnon is to acknowledge and measure dynamic interactions among asset classes.

None of these papers cover periods immediately before, during and after the 2007-2009 financial collapse. Those periods saw large movements in interest rates and asset prices. For example, equity REIT share prices declined by 77% between February 7, 2007 and March 6, 2009, as measured by the MSCI Index of equity REIT share prices.

The dynamic nature of REIT returns and returns on other financial investments is also examined in recent work by Case, Guidolin and Yildirim (2014). They conclude that Markov switching regime models provide better predictions of returns than alternative models such as various ARCH approaches. The Markov switching regime model empirically identifies such shifts. The authors note that regime switches per the model do not always correspond with observers' perceptions of market shifts. That said, their preferred model produces four regimes for joint distributions of equity REIT, stock and bond returns: (1) a "normal" bull market; (2) a higher volatility bull market; (3) a "surge" market with high returns, low volatility and low correlations across assets; and (4) an "investor nightmare" that roughly flips the surge market scenario by exhibiting negative returns, high volatility and high correlation.

There are host of studies concerning time variance of stock-market beta coefficients. A recent study specifically presents annual REIT betas. Cotter and Roll (2015) noted that over the long term (January 1987 through May 2009) the monthly REIT beta based on an average of REIT stocks (not an index) with respect to the S&P 500 averaged 0.58. However, during the financial crisis, the (average) REIT beta soared as high as 1.85 (in 2008). These results are consistent with our findings, presented below, which use daily data.

II. Our Approach

An intuitive empirical specification for measuring the interest-rate sensitivity of an asset is:

$$Price\ Return_t = a + b_1 * \Delta Yield_t + e_t \tag{1}$$

where

$Price\ Return_t$ is the return over an observation period;

$\Delta Yield_t$ is the change in a relevant yield or interest rate over the same observation period;

e_t is a random error term; and

a and b_1 are coefficients to be estimated.

For bonds, estimations of (1) should exhibit high explanatory power, with b_1 being a measure of the average interest-rate sensitivity or empirical duration over the sample period. In contrast, we expect the same specification when applied to stocks, including equity REITs, will have limited explanatory power because the specification excludes potentially relevant factors such as changing expectations about future cash flows and movements in risk premiums.

Most prior work has used REIT returns, either price only or total returns inclusive of dividends, as the dependent variable and some measure of interest rate movement as an explanatory variable, possibly supplemented with additional independent variables. We follow a similar approach, but with a key variation. We use an (imputed) bond return rather than a direct interest-rate measure.[2] We do this because an identical change in, say, the ten-year U.S. Treasury yield will not have the same valuation effect and, thereby, price return, when its yield is 2% than when its yield is 6%. Put another way, what's important for changing values of standard nominal bonds is both yield change and duration.[3] By using a rate of return on a (benchmark) bond we capture both factors that underpin bond price changes.

It also seems reasonable that interest changes affect publicly traded equities in general. To the extent REITs are correlated with the broad equity market, we might expect that some of the effect of interest rate changes on REITs will be channeled through effects on the broad market. It is certainly possible that REITs may be more sensitive – a term that needs to be defined – to interest rates than the market at large, but we can't rule out that they might be no more sensitive or even less sensitive than the overall equity market.

Our approach, which is in the spirit of the asset pricing models of Fama and French (1993), to capturing and controlling for various factors that might affect REIT performance but that are not encapsulated in yield changes is to use both bond returns and stock index returns. In addition, based on the (testable) assumption that the (Treasury) bond return effectively encapsulates the effect of an interest-rate shift on nominally risk-free cash flows, we have a straightforward two-factor model:

$$REIT\ Return_t = a + b_1 * Bond\ Return_t + b_2 * Equity\ Return_t + e_t \quad (2)$$

where b_1 is now a bond beta, rather than a measure of duration, and b_2 is an additional coefficient (equity beta) to be estimated.[4]

This model acknowledges that REIT returns will co-vary with equities. Since interest rate changes may directly affect equity returns, which we can assess using (1), some or all of REITs interest rate sensitivity might be subsumed in that co-variation. As a result, (2) provides an easily testable measure of whether REIT returns are *additionally* influenced by interest rate changes beyond any effect that changing interest rates have on the broad equity market. In essence, b_1 is a measure of (equity) REITs interest-rate sensitivity on the margin, after taking into account any effect transmitted through REITs' exposure to the broad equity market, which is measured by b_2.

In the spirit of Hee, Webb and Mayer (2003) we also posit that REITs may respond differently to changes in riskless yields than they do to changes in credit spreads, which we assume reflect changes in investors' assessment of various risks. These risks might also affect stock valuations. As a result, we expand (2) by including two bond factors: (1) the return on a credit-risk-free Treasury security and (2) the excess return (over the Treasury return) produced by a bond that has credit risk. This expansion gives:

$$REIT\ Return_t = a + b_1 * Treasury\ Bond\ Return_t + b_2 * Excess\ Credit\ Return_t + b_3 * Equity\ Return_t + e_t \quad (3)$$

where b_2 is an additional coefficient to be estimated. [This additional bond coefficient means the equity return coefficient b_2 in (2) is replaced by b_3 in (3).]

We think (3) is a suitable platform for a controlled examination of how interest rate changes have, on the margin, affected REITs over time. For example, during the "flight to safety" caused by the global financial crisis, U.S. Treasury yields declined dramatically, leading to large positive returns on U.S. Treasury securities. At the same time, equity values, including REITS, plunged, and credit spreads widened, leading to bonds with credit risk underperforming Treasuries. Were REITS interest rate sensitive during this period? They certainly did not benefit relative to stocks in general from the decline in Treasury yields.

III. Data

We used the MSCI Equity REIT Index as the source of daily REIT total returns.[5] The Index's inception date is December 30, 1994, with the first return data point on January 3, 1995. The last day in our sample is March 30, 2016. Price-only MSCI index returns do not become available until June 20, 2005, so we opted to use total returns to gain a larger sample size that includes 1990s bull and bear markets in REITs. Mean REIT total return is, of course, higher than REIT price-only return, due to dividends, but second-moment measures such as variance and covariance are nearly identical for the two versions of the REIT index.[6]

For stocks, we used the price-only return on Standard & Poor's 500 Stock Index.

As described in the section above, we used bond returns. We constructed these from two sources: (1) daily constant-maturity U.S. Treasury yields, as calculated by the Treasury Department and (2) daily Moody's Baa corporate bond yields.[7]

In our statistical work, we used the ten-year Treasury as it frequently is cited as a yield benchmark. We constructed the return on this instrument using a straightforward procedure:

1. Assume a bond price of 100 on day t and a coupon rate equal to the published yield for that day.
2. Re-price the bond on the next trading day (day $t+1$, which may or may not be the next calendar date due to weekends and holidays) using the day $t+1$ yield, keeping the coupon payment that was established by the prior (trading) day's yield. (Taking into account days that elapsed between

t and *t+1* does not have a material effect on the present-value calculation, so on day *t+1* we also discounted future payments over exactly ten years.)

We performed an identical set of calculations using the Baa yield.[8]

These calculations give daily price returns on two hypothetical assets: (1) a newly issued (on the previous trading day) ten-year Treasury note and (2) a newly issued (on the previous trading day) Baa bond. The performance of these calculated returns are unlikely to correspond closely to indices constructed from actual individual bonds. For example, the U.S. Treasury 7-10 Year segment of Barclay's Aggregate Index contains multiple bonds, most of which do not have the same duration as a daily new issue ten-year Treasury. It was important for our analysis that our bond returns be tightly tied to their respective interest rate series.

Subtracting the daily Treasury price return from the daily Baa price return provides an excess return measure that captures the effect of changing credit spreads.

Because REIT total returns are the dependent variable, we wanted to have bond returns that corresponded to all dates for which we had REIT returns. In U.S. markets there are days when bonds traded and equities did not and *vice versa*. For example, prior to 1998, equities traded on the Martin Luther King, Jr. holiday, whereas Treasury bonds did not. Our sample provided 5,360 daily observations in total. Stock returns were available on 5,350 of these, but Treasury bond returns were not available for 43 of those days and Baa returns were not available for an additional two days, leaving a sample size of 5,305.[9]-Exhibit 1 provides descriptive statistics and Exhibit 2 shows correlations for the sample.

[Insert Exhibit 1]

We note that the average price return on Baa bonds in Exhibit 1 is lower than on Treasury bonds. However, Baa bond average total return, which adds in coupon payments of interest, exceeds the Treasury's total return, so Baa bondholders over time received compensation for the additional risk they bore. Using our constructed daily bond returns, the Baa total return premium came out to 1.59% annually.

For comparison Barclays data show a 1.51% annual premium for intermediate-term Baa bonds over intermediate-term Treasuries, using monthly returns covering our sample period.

[Insert Exhibit 2]

All correlations are statistically significant, with all t-statistics, which are not reported in the table, having p-values lower than 0.001. Unsurprisingly, the largest pairwise correlation is between Treasury and Baa bond returns. The next largest correlations, in absolute value, are between REIT and stock returns and between Treasuries and the excess return on Baa bonds.

The latter correlation is negative. We believe this reflects a dynamic between credit spreads and changes in Treasury yields. When Treasury yields decline, generating a positive return on Treasuries, the typical reason is softness in macroeconomic conditions. Such macro softness may increase bond default risks, causing credit spreads to widen; thus, even though risky bond returns benefit from the overall yield decline, they tend to underperform Treasuries. When Treasury yields rise, spreads narrow, with the attendant favorable consequences for credit bonds relative to Treasuries. As a result, the observed positive correlation between total returns and negative correlation between excess returns occurs. It is not, however, always the case that rising (falling) Treasury yields correspond with falling (rising) credit spreads. It is just a more frequent occurrence – approximately 72% of the cases in our sample -- than yields and spreads rising or falling in tandem.

III.A Defining Sub-Periods

Several articles, with Cotter and Ross (2015) as a recent example, have shown that REIT betas vary over time. To acknowledge this possibility, we used a simple “low tech” method to divide the data sample into six sub-periods, using successive highs and lows on the MSCI REIT Total Return Index as breakpoints. Exhibit 3 shows the resulting sub-periods and labels we attached to them; Exhibit 4 provides descriptive statistics consistent with those in Exhibit 1.[10]

[Insert Exhibit 3]

[Insert Exhibit 4]

In terms of stylized facts, we characterize market sub-periods as follows:

- Mid-1990s bull market – Strong real estate fundamentals accompanied by a wave of initial public offerings that make REITs institutionally investable.
- Late-1990s bear market – Although fundamentals remain strong REIT stock prices decline, presumably reflecting some combination of over-shooting during the mid-1990s REIT bull market along with rotation away from REITs as investors get caught up in the virtual world of the "dot.com" bubble.
- 2000-2007 bull market – The "dot.com" bubble bursts and investors rotate back to value oriented stocks. The Greenspan Fed compensates for the deflation of the "dot.com" bubble by creating one in real estate. The Fed Funds rate stays well below what the Taylor Rule would suggest, causing credit spreads to collapse and triggering a wave of REIT privatizations highlighted by the Blackstone takeover of the largest office REIT, Equity Office Properties.
- 2007-2009 Crash – A credit crunch envelops the entire economy causing a 60% decline in overall stock prices and making it particularly difficult to fund and refinance leveraged investments.
- 2009-2013 Surge – The Fed adopts a zero interest rate policy along with quantitative easing and credit spreads collapse. Most REITs refinance high cost debt with equity, and the lack of financing for new construction dramatically improves real estate fundamentals.
- 2013 -2016 "Taper Tantrum" and beyond – The Fed hints at retreating from its quantitative easing policy causing a rapid rise in interest rates. As fears of tapering diminish interest rates decline.

IV. Results

Before estimating (3), which is specific to examining the marginal interest-rate sensitivity of REITs, we ran several models that transition from (1) to (3). First, we estimated an expanded version of (1) that includes the credit spread change:

$$Return_t = a + b_1\,\Delta Yield10_t + \; b_2\,\Delta Baa\;Credit\;Spread_t + \; e_t \qquad (4)$$

where

$Return_t$ is the return over successive trading days;

$\Delta Yield10_t$ is the change in the ten-year Treasury yield over successive trading days;

$\Delta Baa\ Credit\ Spread_t$ is the change in the spread (Baa yield minus ten-year Treasury yield) over successive trading days; and

e_t is a random error term.

We estimated (4) for price returns on the ten-year Treasury, Baa bond and S&P500 Index and for the total return on the REIT index. Results are reported in Exhibit 5.

[Insert Exhibit 5]

We set b_2 equal to zero when regressing the Treasury return on its yield change since contemporaneous changes in the Baa credit spread should not affect the Treasury return. The resulting adjusted R-squared, which rounds to 1.0, supports this. We also set b_2 equal to zero for one run with Baa bond return as the dependent variable so that we could assess the effect of introducing the change in credit spread. (As with the Treasury, one would expect a high R-squared when regressing Baa returns on changes in the Baa yield.) This produced an R-squared of 0.74; addition of the change in Baa credit spread moved the adjusted R-squared close to 1.0. None of these results are surprising. However, they confirm the importance of yield changes to the repricing of (1) nominally risk-free cash flows and (2) cash flows subject to default risk. Yield changes appear to encapsulate nearly all factors relevant to daily repricing of fixed cash flow streams, including the risk of not receiving anticipated payments.

These estimations also show that stocks and REITs are sensitive to yield changes. While several regression coefficients are statistically significant, explanatory power is much lower. Adjusted R-squared values were 0.071 and 0.028 for the S&P 500 and REITs, respectively, compared with a minimum of 0.739 for the bond models. Both stock and REIT returns have significantly positive coefficients on Treasury yield changes: Rising Treasury rates, on average over the sample period, were associated with positive equity and REIT returns, in contrast to negative bond returns engendered by rising yields. This finding suggests that while some characteristics of equity REITs may be similar to fixed-income investments, a view that REITs always behave like bonds in response to interest rates changes is not supported with long-run data. S&P 500 returns responded negatively to rising credit spreads. Credit spread changes did not, on average, exhibit a statistically significant effect on REIT returns.

For a second step, we estimated two versions of (3). One excluded the S&P 500 price return, effectively constraining b_2 to be zero. As a result, it is a re-specified version of (1) that uses bond returns rather than yields. The second is the full empirical specification (3). Exhibit 6 provides results estimated over the entire time period.[11]

[Insert Exhibit 6]

With S&P 500 price returns excluded, REITs had a significantly negative Treasury bond beta and a significantly positive beta on Baa excess returns. A negative beta between REITs and bonds indicates REIT returns were low when Treasury yields fell. This is essentially just a re-statement of the result from estimation of (1), the yield version of the specification. However, REITs did exhibit positive returns on average when Baa bonds had positive excess returns, as indicated by a significant positive estimate for b_3.

In the full version of (3) REITs' beta against the S&P 500 was about 0.95.[12] With stock returns included, equity REITs do not appear to have significant betas with respect to Treasury bond returns or Baa bond excess return. This finding suggests that, on average, REIT's may indeed respond to yield changes, but that they do so via their beta against stocks.

IV.A Sub-Period Results

We think sub-period estimation (reported in Exhibit 7) is more informative. Rather than estimate each sub-period as a separate regression, we created binary dummy variables to indicate which of our six sub-periods an observation belonged to. The resulting "system" facilitated statistical tests of coefficient estimates across sub-periods.

As we did for estimations reported in Exhibit 6, we ran both the full estimation of (3) and a version in which the S&P 500 price return was eliminated. In addition, we show results of regressing the S&P 500 price return on the Treasury bond return and excess Baa return to provide a comparison of the overall equity market's betas on Treasury bond returns and Baa excess returns to those of the REIT sector across sub-periods.

[Insert Exhibit 7]

These ancillary regressions serve several purposes. First, they explicitly show similarities and differences between REITs and equities overall in response to bond market variables. Then these results can be used to see the effect of adding (to the REIT regression) the S&P 500 price return. We believe this helps clarify the importance of distinguishing between overall and marginal interest-rate sensitivity.

For example, both REITs and the S&P 500 had highly significant negative betas on Treasury bond returns during the Crash sub-period. This means when Treasury yields declined and generated strong Treasury bond returns (and conversely), REIT and S&P 500 returns were weak, often negative. This empirically confirms the "flight to safety" effect mentioned earlier. However, after re-estimating with S&P 500 price returns added to the model, Treasury bond returns did not have a statistically significant *marginal* effect on REIT returns during the Crash. What did happen was that REITs beta against the S&P 500 went from 0.31 during the preceding 2000s Bull Market sub-period to 1.67 during the Crash. The null hypothesis that these equity market betas were the same is soundly rejected, consistent with findings reported in Cotter and Roll (2015). It is beyond the scope of our research to identify why this equity-market beta shift occurred, but it is clear that REITs' exposure to an array of systematic risk factors, including changing bond yields, ratcheted up dramatically.

Before reviewing the results from (3) for sub-periods, we offer a few additional observations from the two ancillary regressions.

The S&P 500 price return has significant coefficients on Treasury bond returns in each of the sub-periods and is strongly related to Baa excess returns in four of six sub-periods. There is clear temporal variation in coefficient magnitudes. Most notably, coefficients sometimes change sign. Using Wald tests, the only Treasury bond return coefficients that are not significantly different from one another are those from the Crash and Surge periods. For the four sub-periods with significant coefficients on Baa excess return, we cannot reject a null hypothesis that the Mid 90s REIT Bear Market, the 2000s Bull Market and the Crash Baa excess return betas are equal, but we can reject the null for other pairwise tests.

The comparable (S&P 500 price return excluded) REIT estimates show significant Treasury bond betas in only two of six sub-periods, Crash and Surge. Unlike the S&P 500, however, these coefficients for REIT total returns are significantly different statistically. REIT returns were affected by excess credit returns in three periods, all of which are sub-periods in which S&P 500 returns also show this effect. Interestingly, in the REIT case we cannot reject a null that the Mid 90s REIT Bear Market, the 2000s Bull Market and the Crash Baa excess return betas are equal, similar to our finding for S&P 500 price returns.

This brings us back to the question we posed earlier: Are REITs more (less than, equally) interest-rate sensitive than stocks in general? As noted earlier, our findings suggest that during the Crash sub-period, REITs do not appear, on the margin, to have higher or lower sensitivity to Treasury bond return: the coefficient b_1 from the full specification (3) with the S&P 500 return included is not significantly different from zero.

What we do see is that in three sub-periods (2000s Bull Market, Surge and Taper Tantrum and Beyond) REITs had positive (marginal) Treasury bond betas in addition to any interest-rate sensitivity embedded in S&P 500 price returns and transmitted to REITs via REITs equity beta. But it does not necessarily follow that falling interest rates were good for REITs in all these cases. During the Surge, for instance, REITs "absolute" Treasury bond beta was negative, as was the S&P 500's. REITs also had a high equity beta. It seems likely that the positive marginal effect, measured by b_1 in equation (3), picks up a "buffering" between the basic negative bond beta (of REITs and S&P 500 during the period) and REITs high equity beta.

Responses to excess Baa bond returns are different, but seem to be accompanied by a similar buffering effect. During the Crash, both REITs and the S&P 500 show positive betas on Baa excess returns: when credit spreads came down, leading to Baa outperformance, equities also benefited. However, REITs marginal sensitivity was negative after taking into account S&P 500 returns and REIT's (high) equity beta.

IV.B Sensitivity to Sub-Period Definitions

We acknowledge that our delineation of sub-periods is somewhat ad hoc. There are many alternative partitions of the sample, too many to examine rigorously. In addition, endogenous determination of sub-periods, such as the regimes described by Case, Guidolin and Yildirim (2014), can be undertaken, albeit with the need for more powerful estimation techniques.

That said, we examined one additional sub-period, the year following Lehman Brothers bankruptcy filing on September 15, 2008. It is widely viewed that this event exacerbated concerns about a possible collapse of the financial system and led to a surge in market volatility. The post-Lehman Brothers year includes portions of our Crash and Surge sub-periods. Consequently, we can look at whether response coefficients during the year were similar to those estimated for the longer sub-periods and whether or not coefficients within the post-Lehman Brothers year varied across the breakpoint (March 6, 2009) that divides Crash and Surge. Results from estimating equation (3) are in Exhibit 8.

[Insert Exhibit 8]

The only statistically significant coefficients during the post-Lehman Brothers year are betas on the S&P 500 price return. However, the signs on the Treasury bond and Baa bond excess price return coefficients are directionally the same as for the full Crash and Surge sub-periods (see Exhibit 7). For the full sub-periods, three of four bond betas are statistically significant; the Crash sub-period Treasury bond beta is not statistically different from zero. Moreover, for the full sub-periods all coefficients on returns are statistically different between the sub-periods. For the post-Lehman Brothers year, we can reject a null that the S&P 500 betas are the same. Other coefficients are not statistically distinct from zero, so a null hypothesis of equality cannot be rejected.

Results from this alternative sub-period suggest that time-varying coefficients are not likely an artifact of our particular division of the sample into sub-periods.

V. Conclusion

Based on our empirical results, we conclude that no reliable long-run predictive rule of thumb for how REITs respond to interest rate changes exists. Indeed, it may not be possible to make a general statement about how an interest rate change will affect REIT returns, but in the short run REITs can be highly sensitive to changes in interest rates – sometimes.

What is apparent from our findings is that, unsurprisingly, there is time variation in how REIT returns respond to equity and bond market factors. Our results also suggest that while REIT returns were extraordinarily volatile during the financial crisis and immediately thereafter, this volatility manifested as an extreme increase in REITs beta against the equity market, even though REITs and stocks in general exhibited greater sensitivity to bond returns during these periods. Simply put, instead of being bond-like, equity REIT returns at times are totally dominated by fluctuations in overall stock prices.

Although it is beyond the scope of this article to propose and test hypotheses about why REITs exhibit the observed time-varying responses to interest rates changes we can make an informed speculation about recent behavior (Taper Tantrum and Beyond sub-period). We suspect that the marginal sensitivity of

REITs to changes in interest rates during this sub-period, which is indicated by a statistically significant Treasury bond beta [b_1 in equation (3)], is a result of Federal Reserve policy that prompted some investors to acquire REITs as a higher yielding alternative to traditional fixed income investments, whose yields had declined substantially. Thus as investor perceptions changed as to the future course of policy as reflected in changes in the 10-year U.S. Treasury rates, REITs, in addition to a 0.91 beta on the S&P 500, had their highest marginal interest-rate sensitivity (with a Treasury bond beta of 0.81) of all of the sub-periods we covered.

Endnotes

[1] To be sure, yield and credit spread changes can reflect a host of economic and capital markets factors, such as altered expectations about economic growth, regulatory shifts and changes in risk aversion, among others.

[2] Case, Guidolin and Yildirim (2014) include Treasury bond returns, but they use monthly rather than daily data.

[3] For short intervals, such as daily, the price return on a bond is almost exactly equal to the product of the bond's duration and the change in its yield.

[4] Equation (2) is conceptually similar to the approach used by Giliberto and Hash (1995) to study monthly equity REIT returns, S&P 500 returns and interest-rate changes over the January 1973 to September 1995 period.

[5] RMS includes only equity REITs. By definition the majority of these REITs' assets are properties, not debt instruments such as mortgages. This characteristic is important since debate around REIT interest-rate sensitivity is almost always focused on equity REITs. It is expected that mortgage REITs, which are basically financial intermediaries, will be sensitive to interest rates.

[6] The average daily REIT price return was 0.037% over the June 20, 2005 to March 30, 2016 period. The average daily total return was 0.054% over the same time period. Standard deviations were 2.422% and 2.423%, respectively. The correlation between the two series is effectively 1.0. We estimated our various specifications using both price and total return series

for REITs and the S&P 500 and found no significant differences. These results are not reported, but are available from the authors.

[7] Both series were obtained from the Federal Reserve Board of Governors web site. Business-day yield data are published in the H.15 bulletin and full histories are available for download.

[8] One potential issue is that we do not know term to maturity and/or duration for the Baa yield series. We assumed ten years to match the ten-year Treasury. Consequently, our calculated daily Baa bond returns are not as precise as the Treasury bond returns. However, we expect that the Baa returns are reasonable for use in regressions as instruments for excess return.

[9] In addition, bond and stock returns were measured over different intervals for 51 of the 5,305 observations in the sample. The difference arises from variation in holiday observance and attendant market closures that we noted. Including and excluding these observations had no meaningful effect on the empirical results we report.

[10] Correlation matrices for sub-periods are available from the authors upon request.

[11] Because daily stock returns often exhibit (negative) autocorrelation, we also estimated our models with (1) a one-period lag of the dependent variable and (2) with a first-order autoregressive term. We did not find any significant differences in estimated coefficients or their statistical significance. As a result, these results are not reported.

[12][12] We tested this value against a null hypothesis that the REIT index's beta against stocks was 1.0. That null is rejected with a p-value of less than 0.001. We also estimated the equity beta with no interest-rate variables present and found it was essentially unchanged.

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Exhibit 1 | Descriptive Statistics: Daily Returns January 3, 1995 Through March 30, 2016

	10-Year Treasury Price Return	Baa Bond Price Return	Baa Bond Excess Return	Equity REIT Total Return	S&P 500 Price Return
Mean	0.0094%	0.0062%	-0.0032%	0.0547%	0.0331%
Median	0.0000%	0.0000%	0.0000%	0.0640%	0.0640%
Maximum	4.4860%	1.9920%	1.2960%	18.7840%	10.7890%
Minimum	-2.4820%	-2.8270%	-2.9500%	-19.7380%	-9.0350%
Std. Dev.	0.4874%	0.3742%	0.2483%	1.7149%	1.1994%
Observations	5305				

Note: Baa Bond excess return equals Baa Bond Price Return minus 10-Year Treasury Price Return

Exhibit 2 | Correlations of Daily Returns January 3, 1995 Through March 30, 2016

	10-Year Treasury Price Return	Baa Bond Price Return	Baa Bond Excess Return	Equity REIT Total Return	S&P 500 Price Return
10-Year Treasury Price Return	1.000	0.866	-0.658	-0.178	-0.276
Baa Bond Price Return	0.866	1.000	-0.193	-0.136	-0.200
Baa Bond Excess Return	-0.658	-0.193	1.000	0.144	0.240
Equity REIT Total Return	-0.178	-0.136	0.144	1.000	0.660
S&P 500 Price Return	-0.276	-0.200	0.240	0.660	1.000

Sample contained 5305 observations

Note: Baa Bond excess return equals Baa Bond Price Return minus 10-Year Treasury Price Return

Exhibit 3 | Division of Sample into Sub-periods

	Start Date	End Date	RMS Start	RMS End	N Obs
Mid 90s REIT Bull Market	1/3/95	10/6/97	200.00	367.35	694
Late 90s REIT Bear Market	10/7/97	12/15/99	367.35	266.24	547
2000s Bull Market	12/16/99	2/7/07	266.24	1329.76	1781
Crash	2/8/07	3/6/09	1329.76	345.82	519
Surge	3/7/09	5/21/13	345.82	1533.50	1051
Taper Tantrum and Beyond	5/22/13	3/30/16	1533.50	1851.94	713
Full Period	1/3/95	3/30/16	200.00	1851.94	5305

RMS is the MSCI REIT Index for total return

N Obs reflect days with both stock market and bond market returns

Exhibit 4 | Descriptive Statistics By Sub-period

Panel A. Mid 90s REIT Bull Market

	10-Year Treasury Price Return	Baa Bond Price Return	Baa Bond Excess Return	Equity REIT Total Return	S&P 500 Price Return
Mean	0.0222%	0.0167%	-0.0055%	0.0879%	0.1099%
Median	0.0000%	0.0000%	0.0000%	0.0810%	0.0950%
Maximum	1.7000%	1.0490%	0.9950%	2.0140%	3.1250%
Minimum	-2.4820%	-1.4870%	-1.0870%	-2.2650%	-3.0830%
Std. Dev.	0.4226%	0.3126%	0.1749%	0.4133%	0.7469%
Observations	694				

Panel B. Late 90s REIT Bear Market

	10-Year Treasury Price Return	Baa Bond Price Return	Baa Bond Excess Return	Equity REIT Total Return	S&P 500 Price Return
Mean	-0.0043%	-0.0084%	-0.0041%	-0.0564%	0.0734%
Median	0.0000%	0.0000%	0.0000%	-0.1010%	0.0860%
Maximum	1.4980%	0.9100%	1.0100%	4.1810%	5.1150%
Minimum	-1.7510%	-1.7600%	-1.0850%	-4.8480%	-6.8660%
Std. Dev.	0.4352%	0.2808%	0.2394%	0.7695%	1.2627%
Observations	547				

Panel C. 2000s Bull Market

	10-Year Treasury Price Return	Baa Bond Price Return	Baa Bond Excess Return	Equity REIT Total Return	S&P 500 Price Return
Mean	0.0062%	0.0082%	0.0020%	0.0947%	0.0083%
Median	0.0000%	0.0000%	0.0000%	0.1070%	0.0420%
Maximum	1.7270%	1.3830%	1.2960%	4.7710%	5.7330%
Minimum	-1.9680%	-1.2750%	-1.4090%	-5.0940%	-5.8280%
Std. Dev.	0.4572%	0.3272%	0.2331%	0.8945%	1.1236%
Observations	1781				

Panel D. Crash

	10-Year Treasury Price Return	Baa Bond Price Return	Baa Bond Excess Return	Equity REIT Total Return	S&P 500 Price Return
Mean	0.0328%	-0.0240%	-0.0568%	-0.1872%	-0.1392%
Median	0.0000%	0.0000%	-0.0150%	-0.2230%	0.0380%
Maximum	2.3920%	1.7500%	1.1520%	18.7840%	10.7890%
Minimum	-1.9830%	-2.8270%	-2.4160%	-19.7380%	-9.0350%
Std. Dev.	0.6399%	0.4878%	0.3830%	3.8562%	1.9889%
Observations	519				

Exhibit 4 | Descriptive Statistics By Sub-period (continued)

E. Surge

	10-Year Treasury Price Return	Baa Bond Price Return	Baa Bond Excess Return	Equity REIT Total Return	S&P 500 Price Return
Mean	0.0075%	0.0241%	0.0165%	0.1586%	0.0871%
Median	0.0000%	0.0000%	0.0140%	0.1760%	0.0920%
Maximum	4.4860%	1.9920%	1.2690%	17.2130%	7.0760%
Minimum	-1.9900%	-2.2090%	-2.9500%	-11.2120%	-6.6630%
Std. Dev.	0.5480%	0.4603%	0.2618%	2.2371%	1.2074%
Observations	1051				

F. Taper Tantrum and Beyond

	10-Year Treasury Price Return	Baa Bond Price Return	Baa Bond Excess Return	Equity REIT Total Return	S&P 500 Price Return
Mean	0.0010%	-0.0021%	-0.0032%	0.0309%	0.0353%
Median	0.0000%	0.0000%	-0.0070%	0.0760%	0.0420%
Maximum	1.4820%	1.0050%	0.7240%	3.4120%	3.9030%
Minimum	-1.8270%	-1.3700%	-0.7950%	-4.7380%	-3.9410%
Std. Dev.	0.4315%	0.3643%	0.1980%	1.0074%	0.8559%
Observations	713				

Note: Baa Bond excess return equals Baa Bond Price Return minus 10-Year Treasury Price Return

Exhibit 5 | Regression Estimates: Full Sample

$$Return_t = a + b_1 * \Delta Yield10_t + b_2 * \Delta Baa\ Credit\ Spread_t + e_t$$

	Dependent Variable				
	10-Year Treasury Price Return	Baa Bond Price Return	Baa Bond Price Return	S&P 500 Price Return	Equity REIT Total Return
Independent Variable					
Intercept (x1000): a	0.004	-0.001	0.004	0.390	0.601
t-stat	0.816	-0.021	1.288	2.454	2.590
p-value	0.415	0.983	0.198	0.014	0.010
Change in 10-yr Treasury Yield: b_1	-0.081	-0.054	-0.072	0.045	0.046
t-stat	-1076.872	-122.729	-1270.571	14.875	10.302
p-value	0.000	0.000	0.000	0.000	0.000
Change in Baa Credit Spread: b_2	NA	NA	-0.072	-0.028	-0.010
t-stat	NA	NA	-643.136	-4.680	-1.178
p-value	NA	NA	0.000	0.000	0.239
Adjusted R-Squared	0.995	0.739	0.997	0.071	0.028
DW	1.945	1.857	1.921	2.112	2.317
N observations	5305	5305	5305	5305	5305

Exhibit 6 | Regression Estimates: Full Sample

Panel A. $REIT\ Return_t = a + b_1 * Treasury\ Bond\ Return_t + b_2 * Excess\ Credit\ Return_t + e_t$

	Coefficient Value	t-stat	p-value
Intercept (x1000): a	0.606	2.616	0.009
Treasury Bond Return: b_1	-0.516	-8.177	0.000
Excess Credit Return: b_2	0.326	2.635	0.008
Adjusted R-Squared	0.032		
DW	2.316		
N observations	5305		

Panel B. $REIT\ Return_t = a + b_1 * Treasury\ Bond\ Return_t + b_2 * Excess\ Credit\ Return_t + b_3 * Equity\ Return_t + e_t$

	Coefficient Value	t-stat	p-value
Intercept (x1000): a	0.232	1.308	0.191
Treasury Bond Return: b_1	-0.032	-0.651	0.515
Excess Credit Return: b_2	-0.149	-1.568	0.117
S&P 500 Price Return: b_3	0.948	61.627	0.000
Adjusted R-Squared	0.436		
DW	2.227		
N observations	5305		

Exhibit 7 | Regression Estimates: Sub-periods

*Panel A. REIT Total Return$_t$ = a + b_1 * Treasury Bond Return$_t$ + b_2 * Excess Credit Return$_t$ + e_t*

	Sub-period	Coefficient Value	t-stat	p-value	
Intercept (x1000): a	Mid 90s REIT Bull Market	0.795	1.283	0.200	
	Late 90s REIT Bear Market	-0.529	-0.757	0.499	
	2000s Bull Market	0.916	2.369	0.018	**
	Crash	-0.878	-1.212	0.226	
	Surge	1.773	3.513	0.000	***
	Taper Tantrum and Beyond	0.306	0.501	0.617	
Treasury Bond Return: b_1	Mid 90s REIT Bull Market	0.418	1.875	0.061	*
	Late 90s REIT Bear Market	0.182	0.672	0.502	
	2000s Bull Market	0.224	1.805	0.071	*
	Crash	-1.838	-12.488	0.000	***
	Surge	-1.328	-12.105	0.000	***
	Taper Tantrum and Beyond	0.255	1.515	0.130	
Excess Credit Return: b_2	Mid 90s REIT Bull Market	0.159	0.295	0.768	
	Late 90s REIT Bear Market	0.687	1.398	0.162	
	2000s Bull Market	0.820	3.361	0.001	***
	Crash	0.687	2.794	0.005	***
	Surge	-0.526	-2.291	0.022	**
	Taper Tantrum and Beyond	-0.005	-0.014	0.989	
Adjusted R-Squared (for equation system)		0.096			
DW		2.300			
N observations		5305			

* marginally significant (10% level)
** significant at 5% level
*** significant at 1% level

Exhibit 7 | Regression Estimates: Sub-periods

*Panel B. S&P 500 Price Return$_t$ = a + b_1 * Treasury Bond Return$_t$ + b_2 * Excess Credit Return$_t$ + e_t*

	Sub-period	Coefficient Value	t-stat	p-value	
Intercept (x1000): a	Mid 90s REIT Bull Market	0.888	2.126	0.034	**
	Late 90s REIT Bear Market	0.811	1.725	0.085	*
	2000s Bull Market	0.071	0.273	0.785	
	Crash	-0.507	-1.038	0.299	
	Surge	1.046	3.076	0.002	***
	Taper Tantrum and Beyond	0.361	0.878	0.380	
Treasury Bond Return: b_1	Mid 90s REIT Bull Market	0.995	6.618	0.000	***
	Late 90s REIT Bear Market	0.463	2.539	0.011	**
	2000s Bull Market	-0.211	-2.514	0.012	**
	Crash	-1.058	-10.672	0.000	***
	Surge	-1.147	-15.519	0.000	***
	Taper Tantrum and Beyond	-0.606	-5.366	0.000	***
Excess Credit Return: b_2	Mid 90s REIT Bull Market	0.173	0.477	0.633	
	Late 90s REIT Bear Market	1.418	4.279	0.000	***
	2000s Bull Market	1.233	7.506	0.000	***
	Crash	0.946	5.707	0.000	***
	Surge	-0.538	-3.481	0.001	***
	Taper Tantrum and Beyond	0.070	0.282	0.778	
Adjusted R-Squared (for equation system)		0.161			
DW		2.119			
N observations		5305			

* marginally significant (10% level)
** significant at 5% level
*** significant at 1% level

Exhibit 7 | Regression Estimates: Sub-periods

*Panel C. REIT Total Return$_t$ = a + b_1 * Treasury Bond Return$_t$ + b_2 * Excess Credit Return$_t$ + b_3 * Equity Return$_t$ + e_t*

	Sub-period	Coefficient Value	t-stat	p-value	
Intercept (x1000): a	Mid 90s REIT Bull Market	0.633	1.566	0.117	
	Late 90s REIT Bear Market	-0.746	-1.652	0.099	*
	2000s Bull Market	0.889	3.559	0.000	***
	Crash	-0.029	-0.063	0.950	
	Surge	0.112	0.342	0.732	
	Taper Tantrum and Beyond	-0.023	-0.057	0.954	
Treasury Bond Return: b_1	Mid 90s REIT Bull Market	0.237	1.506	0.132	
	Late 90s REIT Bear Market	0.058	0.329	0.742	
	2000s Bull Market	0.305	3.796	0.000	***
	Crash	-0.066	-0.671	0.503	
	Surge	0.493	6.247	0.000	***
	Taper Tantrum and Beyond	0.806	7.148	0.000	***
Excess Credit Return: b_2	Mid 90s REIT Bull Market	0.127	0.365	0.715	
	Late 90s REIT Bear Market	0.307	0.954	0.340	
	2000s Bull Market	0.345	2.153	0.031	**
	Crash	-0.896	-5.572	0.000	***
	Surge	0.329	2.205	0.028	**
	Taper Tantrum and Beyond	-0.069	-0.290	0.772	
S&P 500 Price Return: b_3	Mid 90s REIT Bull Market	0.182	2.882	0.004	***
	Late 90s REIT Bear Market	0.268	7.408	0.000	***
	2000s Bull Market	0.385	16.396	0.000	***
	Crash	1.674	63.160	0.000	***
	Surge	1.588	52.169	0.000	***
	Taper Tantrum and Beyond	0.909	18.711	0.000	***
Adjusted R-squared (for equation system)		0.623			
DW		2.159			
N Observations		5305			

* marginally significant (10% level)
** significant at 5% level
*** significant at 1% level

Exhibit 8 | Regression Estimates: One Year Sub-Period Following Lehman Brothers Bankruptcy

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*REIT Return$_t$ = a + b$_1$ * Treasury Bond Return$_t$ + b$_2$ * Excess Credit Return$_t$ + b$_3$ * Equity Return$_t$ + e$_t$*

Panel A. Entire Sub-Period

	Coefficient Value	t-stat	p-value
Intercept (x1000): a	0.002	0.798	0.426
Treasury Bond Return: b_1	-0.223	-0.715	0.475
Excess Credit Return: b_2	-0.778	-1.657	0.099
S&P 500 Price Return: b_3	1.879	23.779	0.000
Adjusted R-Squared	0.718		
DW	2.330		
N observations	250		

Panel B. Portion During Crash Sub-Period

	Coefficient Value	t-stat	p-value
Intercept (x1000): a	0.001	0.452	0.652
Treasury Bond Return: b_1	-0.140	-0.342	0.733
Excess Credit Return: b_2	-0.933	-1.633	0.104
S&P500 Price Return: b_3	1.761	19.141	0.000
Adjusted R-Squared	0.715		
DW	2.330		
N observations	118		

Panel C. Portion During Surge Sub-Period

	Coefficient Value	t-stat	p-value
Intercept (x1000): a	-0.003	-0.853	0.395
Treasury Bond Return: b_1	0.083	0.169	0.866
Excess Credit Return: b_2	0.586	0.678	0.498
S&P 500 Price Return: b_3	2.447	14.861	0.000
Adjusted R-Squared	0.762		
DW	2.080		
N observations	132		