REIT Stock Price Volatility during the Financial Crisis

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Abstract

This paper sheds light on several puzzling empirical observations. We examine the volatility implications of equity REIT stock returns over the sample period from January 1985 through October 2012. We find a negative "leverage effect" in the pre- and post-Greenspan era, but not during the Greenspan era (circa 1994 to 2006). We argue that the positive elasticity of variance with respect to the value of equity during the Greenspan era can be explained by low and declining interest rates, which triggered a wealth transfer from REIT equity holders to REIT debt holders. We also argue that the low and declining interest rates during the Greenspan era allowed REITs to take on far more risk than most people realized. We then document that average REIT stock return volatility increased significantly in the 2007-2010 period in the midst of a historic decline in REIT stock prices. The results have significant implications for the good deal of interest and debate in the media over the status of REITs and whether equity REITs have become excessively risky relative to the returns they generate.

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1. Introduction

The recent increase of average REIT stock return volatility in the 2007-2010 period (see Figure 1, which shows the standard deviation of the total monthly return on the equity National Association of Real Estate Investment Trust (NAREIT) index) is not as puzzling as it appears at first glance. A large part of the increase (as we shall argue below) can be explained by a long period of low and declining interest rates in the Greenspan era (circa 1994 to 2006). The low interest rates of that period triggered a wealth transfer from REIT equity holders to REIT debt holders and raised the financial leverage ratio of REITs (defined as the market, rather than the face, value of debt divided by the market value of equity). At the same time, the ratio of the total face value of debt divided by the market value of equity declined, leaving most REITs headroom (as long as business and financial risk did not materialize) to take on more (relatively cheap) debt to push their yields even higher. Financed with a capital structure with heavier amounts of (albeit relatively low-cost) debt, REITs harbored far more risk than most people realized. At this juncture, the developments in the financial crisis of 2007-2009 (i.e., increased business and financial risk) led to declining stock prices. As stock prices fell, other things equal, the market financial leverage ratio and equity volatility for REITs increased.[1]

The balance sheets of REITs are very susceptible to external shocks. This vulnerability is not a new situation. It has been something REITs have had to deal with on a regular basis. It is caused by REITs' inability to retain significant amounts of cash flow. REITs are also more dependent on short-term liquidity sources than companies in other sectors because of

[1] Other literature about REIT volatility suggests that leveraged or inverse-exchange traded funds (ETFs) have exacerbated intraday REIT volatility. See Bond and Hatch (2011), and Boney and Sirmans (2008). But leveraged or inverse-ETFs alone cannot explain the increase of average REIT stock return volatility over the 2007-2010 period.

their inability to retain significant amounts of cash flow. REITs typically utilize short-term liquidity sources to acquire properties and fund certain development and capital expenditures. Thus, during periods of liquidity stress in the capital markets REITs can be subject to a rather large leverage effect intertemporally.

A simple test of this theory presents itself. These events make clear that the relation between changes in equity value and equity volatility for levered REITs may at times be positive or negative. Indeed, before and after the Greenspan era, when REIT stock prices were increasing, we would have expected a negative relation between equity value and volatility. However, during the Greenspan era, we would have expected the relation between the variance of equity returns and REIT stock price to be positive. As explained by Black (1976), the former is consistent with classical contingent claims theory made in Merton (1974). The latter is consistent with the argument made in Christie (1982) and elsewhere. The latter is also consistent with evidence that, on average, stocks react negatively to both the interest rate (expected inflation) and unexpected inflation.

The results reported here have important implications. The financial press often compares investing in REIT stocks to investing in fixed-income bonds. However, in today's environment reports have begun to appear that with the high yield on REIT stocks also comes a high degree of risk, and that this high degree of risk makes REIT stocks an extremely volatile investment alternative to (lower yielding/lower risk) fixed income and/or treasury products (see, e.g., Campbell (2011) writing in U.S. News & World Report). This assertion overlooks two important factors. First, that REITs have delevered notably since 2007. Holding firm volatility constant, a decrease in the ratio of the total face value of debt divided by the market value of equity implies a decrease in equity volatility. Second, REITs have enjoyed a large increase (i.e., rebound) in stock values since 2007. With a negative variance/stock price relation, the price effect implies (if our empirical results as reported below are valid) a decrease, rather than an increase, in REIT equity volatility.

Testing for a negative/positive relation between volatility and the value of equity for REITs occupies the remainder of the paper. The next section quickly reviews the contingent claims literature on the links between equity volatility and equity value. The third section reviews the literature on the relationship of equity volatility and equity value caused by an increase/decrease in interest rates. The model provides motivation for the empirical tests. The fourth section describes the data used in the analysis. The fifth section presents tests of trade-off between equity volatility and equity value for all equity REIT stocks that comprise the FTSE National Association of Real Estate Investment Trust (NAREIT) Equity REIT index. Separate tests are presented to examine the sensitivity of the results to different subperiods. We find a negative REIT stock price elasticity of variance before and after the Greenspan era, but not during the Greenspan era. The sixth section reports some additional checks of robustness. The checks serve to validate the core findings. The concluding section summarizes the main findings of the paper. The results are significantly different from those given by Schwert (1989, 2010).

2. Merton's Model of Equity Volatility

2.1 Contingent Claims Theory

Merton (1974) presents a model of equity and debt valuation in which financial markets are assumed to be perfect. The model assumes that a firm with initial value V issues a zero-coupon bond with face value D and maturity T. Firm value is assumed to be lognormally distributed and trading is continuous. Interest rates, the payout rate, and volatility are all assumed constant. The firm is assumed to follow a pattern of rational default. That is, default occurs at the maturity of the discount debt if $V < D$, which means that equity is an option on firm value that pays $Max(V - D, 0)$ at time T.

Under the condition of risk-free debt and costless bankruptcy, the Black and Scholes (1973) formula gives the value of equity of the firm, S. Here S increases with 1) an increase in value of the firm's assets, V, 2) an increase in the variance of the value of the firm's assets, and 3) an increase in the time to maturity of the amount of debt D. The value of the debt, D, is equal to firm value minus the value of equity. With respect to the value of the firm, firm value is completely independent of the type of financing used for its projects. That is, the Modigliani-Miller proposition of leverage irrelevance holds.

The upshot of Merton's model is that for a given firm

$$\sigma_S = (VS_V/S) \times \sigma_V \tag{1}$$

where σ denotes the standard deviation of the rate of return, S_V is the derivative of equity value with respect to firm value (i.e., the call option's delta), and V and S represent the market values of the firm and equity respectively. Options delta values range from 0 to 1. Options delta values rise as options get more and more in-the-money and reduce as the options get more and more out-of-the-money. With $S_V = 1$, (1) reduces to

$$\sigma_S = (1 + LR) \times \sigma_V \tag{2}$$

where $LR = D/S$ is the market financial ratio. Equation (2) makes clear that as the value of equity increases, the firm becomes less levered and as a result the volatility of equity falls. That is, there is a negative relation between equity volatility, σ_S, and the value of equity, S. The negative relation between equity volatility and the value of equity is also implied in the Cox and Ross (1976) model of equity and debt valuation.

2.2 Empirical Implementation

Beckers (1980) is an example of an attempt to test the link between equity volatility and the value of equity in the Cox and Ross (1976) model. For example, for ordinary stocks Beckers (1980) reports a regression of the form:

$$ln\sigma_S = \kappa_0 + \kappa_1 lnS + \varepsilon \tag{3}$$

where ε is a random error term. The value of κ_1 in this model should vary from -1 to 0. Hence, equity volatility is an inverse function of stock price.

Christie (1982) performs related tests, in that he estimates

$$ln(\sigma_S/\sigma_{S_{-1}}) = \beta_0 + \beta_1 ln(S/S_{-1}) + \mu \tag{4}$$

Christie's (1982) regression model can be derived from (2) by assuming that the elasticity of equity volatility with respect to stock price is an intertemporal constant, and then by adding an intercept, β_0, and an error term, μ. Empirically, one should expect the slope term, β_1, to be between -1 and 0 (ignoring estimation error and econometric problems).

Cheung and Ng (1987), Ritchken and Trevor (1999) and others propose a EGARCH formulation for estimating the inverse relation between stock price and equity volatility, which has the desirable property that stock returns are function of conditional volatility. The model can be written as

$$r = a + bh + cr_{-1} + u \tag{5}$$

$$\ln h = \alpha + \gamma \ln h_{-1} + \sum_{j=1}^{2} \lambda_j z_{-j} + \theta lnS_{-1} \tag{6}$$

where

$$u \sim N(0, h)$$

$$z_{-k} = [|\psi_{-k}| - (2/\pi)^{0.5} + \eta\psi_{-k}]$$

$$u_{-k} = \psi_{-k}\sqrt{h_{-k}}$$

$$\psi \sim i.i.d.N(0, 1)$$

r is the rate of return on equity and h is the variance of the error term, u, conditioned on information available at time $t-1$. The conditional variance is a function of four terms: the constant, α, the ARCH terms, z_{-k}, the GARCH term, $\ln h_{-1}$, and the log stock price, lnS_{-1}. The ARCH term tests for whether volatility propagates over time (i.e., whether a volatility shock from prior periods leads to an increased volatility today). The GARCH term captures whether large volatility shocks cause a large and persistent increase in volatility.[2] The log stock price is incorporated in (6) to test whether equity returns become more volatile as stock prices decrease. In (5), the value of b should be positive. That is, returns should be higher during times of higher volatility. In (6), to model persistence of higher volatility, one needs a process with positive values for γ and λ_k. Lastly, in (6) the coefficient θ should be negative.

[2] Using the GARCH model given can be justified by appealing to the recent work by Case, Guidolin and Yildirim (2011), who find evidence of conditional heteroskedasticity in REIT returns.

That is, returns should become more volatility as prices decrease. One of the attractiveness of the relations in (5) and (6) is that it captures the asymmetric effect of lagged shocks on conditional volatility.

In the empirical section that follows, we shall estimate equations (3), (4), and (5)-(6), and contrast the results. We shall be interested in knowing whether REIT equity returns become more volatile as stock prices decrease, and whether a negative relation between REIT stock price and equity volatility is a standard result. We shall also be interested in knowing the effect of an increase/decrease in interest rates on the variance of REIT equity returns. It is possible for REIT equity returns to become more volatile when interest rates fall. So the net effect of an increase in REIT stock prices and a decrease in interest rates could lead to an increase, rather than a decrease, in the REIT equity volatility, depending on which effect is stronger. We turn to this issue next.

3. The Effect of Changing Interest Rates

Christie (1982) documents that increases (decreases) in interest rates can have a negative (positive) impact on the volatility of equity. This result can be shown by differentiating equation (1) directly with respect to the interest rate, r, and evaluating the obtained expression:

$$\partial\sigma_S/\partial r = \sigma_V S^{-1}\left\{V_r\epsilon_S S_V\lambda_S + (VS_{Vr} - \epsilon_S S_r)\right\} \tag{7}$$

where S_V is the partial derivative of S with respect to V, S_r is the partial derivative of S with respect to r, S_{Vr} is the cross partial of S with respect to V and r, V_r is the partial derivative of V with respect to r, ϵ_S is the elasticity of the value of equity with respect to value of the firm (i.e., $\epsilon_S = VS_V/S$), and λ_S is the elasticity of equity volatility with respect to stock price (i.e., $\lambda_S = (\partial\sigma_s/\sigma_S)/(\partial S/S)$).

Since S_{Vr} is negative–an increase in V has less impact on S in a high interest rate environment compared with a low interest rate environment – and S_r is positive – an increase in interest rates makes the equity holder better off, holding all else constant – the term $(VS_{Vr} - \epsilon_S S_r)$ must be negative, given ϵ_S is positive. The term $V_r\epsilon_S S_V\lambda_S$ is positive provided λ_S is negative and $V_r < 0$. In this case, $\partial\sigma_S/\partial r$ is positive if $V_r\epsilon_S S_V\lambda_S > (\epsilon_S S_r - VS_{Vr})$, that is, an increase in interest rates could lead to an increase in volatility where $V_r\epsilon_S S_V\lambda_S > (\epsilon_S S_r) - VS_{Vr})$. Alternatively, if λ_S is positive (as in the case where $V_r = 0$), $\partial\sigma_S/\partial r$ can be negative, and the model has an interesting interpretation. It says that a decline in interest rates (like what took place during the Greenspan era) could lead to a positive association between equity variances and equity value. The intuition is simple enough. A decline in interest rates causes the value of debt and equity both to increase but the debt increases more than the equity. As debt values increase more than the equity, the financial leverage of the firm increases. Because of the positive association between equity variances and financial leverage, the increase in financial leverage leads to an increase in the volatility of the stock, creating a positive relationship between equity variances and equity value that is not fabricated or trumped-up.

Whether declining interest rates during the Greenspan era led to a positive elasticity between REIT equity volatility and stock price is an integral part of our story and is analyzed below. We shall first conduct a test for all REIT stocks in the 1985-1993 period to examine the relation between REIT stock price and equity volatility. Next, we will undertake robustness test by examining the sensitivity of the results to different subperiods. Empirically, one should expect to observe a positive elasticity of REIT equity volatility with respect to the stock price during the Greenspan era and a negative elasticity of REIT equity volatility with respect to the stock price in all other subperiods. Again, we will estimate the models described in equations (3), (4), and (5)-(6), and contrast the results.

4. Data

The basic data consist of monthly returns for all equity REIT stocks of NYSE, AMEX, and NASDAQ-listed companies that comprise the FTSE NAREIT Equity REIT index. The sample period runs from January 1985 through October 2012. We estimate the model first for the subsample period from January 1985 through December 1993 – the pre-Greenspan era – and then from January 1994 through December 2006 – the Greenspan era – and from January 2007 through October 2012 – the post-Greenspan era. The sample is split into these three subsample periods to see if parameters changed in the Greenspan era for the reasons mentioned above.[3]

Using an index made up of all equity REIT stocks to test the hypothesis that the elasticity of REIT equity volatility with respect to the value of equity is negative is somewhat objectionable because the elasticity of leverage may vary with a number of other factors. For example, the propensity for REIT equity volatility to increase with respect to a fall in stock price may vary nonlinearly with operating leverage (i.e., fixed costs) and the revenue (state) generating process. Specifically, it is possible for a small decrease in stock price to have a larger impact on equity volatility if the REIT has a high degree of operating leverage compared to a REIT with a low degree of operating leverage. It is also possible for the behavior of REIT equity

[3] The break in the sample period in January 1994 is roughly consistent with the first full year of what might be considered the modern REIT era. It is possible that the interest rate level played a role in stimulating the modern-side of REITs. Modern REITs are generally distinguished from their predecessors by a number of financial features, including owning higher-quality assets and adopting a more leveraged risk profile. There is a substantial body of literature that explains when financial innovations occur. The evidence on financial innovations points to the conclusion that new innovations largely stem from an increase in the cost of adhering to existing constraints; for example, the rising costs of adhering to existing financing constraints (see, e.g., Silber (1983)). This perspective can be used to explain the steady change in REIT investing and the adoption of a more leveraged risk profile.

volatility to vary with growth and redevelopment opportunities. Everything else equal, REITs with significant growth and redevelopment opportunities should have greater risk (risk and opportunity are two sides of the same coin). Consequently, the elasticity of REIT equity volatility with respect to the value of equity may vary nonlinearly with growth opportunities. Another variable that can impact volatility is firm size. Chan and Chen (1988) and others find that firm size helps to explain the cross-section of average stock returns. Firms with low market equity are more likely to have poor prospect, whereas large stocks are more likely to be firms with stronger prospects. What this suggests is that firm size may have an effect on the relation between equity volatility and financial leverage. Anticipating this, separate equity volatility and stock price indices were prepared for the different groups of REITs.[4]

The underlying data used to construct these indices are from the COMPUSTAT files of income-statement and balance-sheet data. The indices are constructed by taking fiscal year-end fundamental data in calendar year $t-1$ for constituents of the NAREIT index to compute their operating leverage and earnings growth rate. There are several ways to measure earnings growth. We measure earnings growth (defining earnings as earnings before interest, taxes, depreciation and amortization) for each firm as

$$EC_{it} = 100 \times [E_{it} - E_{it-1}] / |E_{it-1}| \quad (8)$$

where EC_{it} is the earnings change for the ith firm in the tth period and E_{it} is earnings per share for the ith firm in the tth period. The use of the absolute value of earnings in the denominator is to correct for negative and positive earnings numbers. The analysis truncates outliers at $\pm 100\%$. This truncation essentially precludes any one observation from dominating

[4] A separate argument for focusing attention on large REITs appears in Cotter and Stevenson (2008). They suggest that the inclusion of REITs in large indices has increased fund flows into the industry and increased daily REIT volatility.

the averages. We measure operating leverage for each firm as

$$DOL_{it} = 100 \times \left\{ \left[\frac{E_{it} - E_{it-1}}{|E_{it-1}|} \right] / \left[\frac{R_{it} - R_{it-1}}{R_{it-1}} \right] \right\} \tag{9}$$

where DOL_{it} is the degree of operating leverage for the ith firm in the tth period and R_{it} is total revenues for the ith firm in the tth period. We use a firm's market equity at the end of December of year $t-1$ to compute its market size (stock price times shares outstanding).

In December of each year, all firms are separately sorted by operating leverage, earnings growth rate, and size to determine mean breakpoint values for each grouping. Firms are then allocated to two size portfolios – high and low – based on these breakpoints. After assigning firms to these (non-mutually exclusive) portfolios in December, we calculate equal-weighted monthly returns on the portfolios for the next 12 months, from December to December. In the end, we have monthly returns for REITs with high and low operating leverage alone, high and low earnings growth rates alone, and for both large and small REITs alone from January 1985 through October 2012. We use these indices to test whether the elasticity of financial leverage varies with operating leverage, earnings growth, and size.

Table 1 reports standard deviations and mean returns for the full period as well as for the three different subperiods for the indices described above. The standard deviation is measured in nominal terms using a rolling six-month window.[5] The standard deviation is annualized by multiplying the monthly volatility by the square root of 12. Over 1985 to 2012, all equity REITs displayed returns of 1.02 percent (or at a rate of 13 percent compounded annually). Higher returns are observed over the 1994-2006 Greenspan era. For instance, all equity REITs

[5] There is evidence in Chung, Fung, Shilling, and Simmons-Mosley (2011), and Diavatopoulos, Fodor, Howton, and Howton (2010) that implied volatility from the REIT option market is generally a good, but not a perfect, estimator of realized volatility in the REIT stock market and vice versa.

displayed returns of 1.24 percent (or 15.9 percent compounded annually) over the period 1994 to 2006. Higher returns are also observed for REITs with high operating leverage compared to REITs with low operating leverage, REITs with high earnings growth compared to REITs with low earnings growth, and large-size REITs compared to small-size REITs. The table also shows that highest standard deviations are observed over more recent periods. For example, all equity REITs experienced an average standard deviation of 45 percent over the period 2007 to 2012 (compared to 28 percent over the period 1985 to 1993). Additionally, REITs with high operating leverage and low earnings growth rate as well as small-size REITs grappled with high standard deviations over the period 2007 to 2012.

As Figure 2 shows, the ratio of debt-to-EBITDA for REITs in the U.S. increased sharply over the 1994-2006 Greenspan era, from 3.7 times EBITDA in 1994 to 6.7 times EBITDA in 2007. Figure 2 also highlights the precipitous downward trend of debt-to-EBITDA in the post-2009, from 8.8 times EBITDA in 2009 to 6.8 times EBITDA in 2012. The trend toward a declining debt-to-EBITDA ratio is consistent with an increasing equity-to-total-asset ratio, increasing from 36 percent in 2009 to 43 percent. The trend is also consistent with more rapid NOI growth in 2009-2012, rates of increase between 9.5 percent and 21.8 percent.[6]

5. Tests of the Financial Leverage Hypothesis

Estimates of models (3), (4), and (5)-(6) for all equity REIT stocks are obtained for each period. The results are presented in Tables 2-4. Table 2 presents the results of the estimations of model (3). Several interesting observations emerge from Table 2. First, we find an inverse relation between REIT stock price and volatility for the subsample period from January

[6] All of these financial ratios are for all US-equity REITs and come from SNL's REIT database, which provides detailed firm classification and financial information of REITs.

1985 through December 1993 and from January 2007 through October 2012, but not over the Greenspan era from January 1994 to December 2006. The estimate of the price variable in the subsample period from January 1985 to December 1993 is -0.89 and statistically significant at conventional levels. A plot of the standard deviation of REIT stock prices against the logarithm of stock price from January 1985 to December 1993 is given in Figure 3. The plot confirms a negative downward trend. The estimate of the price variable in the January 1994 to December 2006 period is 0.43, with a t-statistic of 2.5 (significant at the 5 percent level). A plot of the standard deviation of REIT stock prices against the logarithm of stock price from January 1994 to December 2006 is given in Figure 4. The plot confirms an upward positive trend. The estimate of the price variable in the subsample period from January 2007 through October 2012 is -1.45, with a t-statistic of -9.7 (significant at the 1 percent level). A plot of the standard deviation of REIT stock prices against the logarithm of stock price from January 2007 through October 2012 is given in Figure 5. The plot confirms a negative downward trend. So in the pre- and post-Greenspan era, the lower are REIT stock prices, the higher is REIT volatility. However, in the Greenspan era, the higher are REIT stock prices, the higher is REIT volatility. Second, estimates of the leverage effect in the pre- and post-Greenspan era are generally consistent with Beckers (1980), Christie (1982), and French, Schwert, and Stambaugh (1987), who estimate an average cross-sectional stock price elasticity of variance for ordinary firms to be between -0.40 and -3.38. Third, the results are contrary to Schwert (1989), who finds that leverage had a relatively small effect on stock volatility during the 1929-1940 Great Depression. In contrast, in a similar analysis of stock volatility during the recent financial crisis, Schwert (2010) shows that the volatility of stock prices, particularly among financial sector stocks, was on the whole linked with real economic activity.

Table 3 presents the results of the estimations of model (4). The coefficient of the price ratio variable indicates the leverage effect on REIT volatility. In the pre- and post-Greenspan era, the coefficient of the price ratio variable is negative but not significant. In the Greenspan era, the coefficient of the price ratio variable turns positive but not significant. The statistical problem is that the independent variable varies across time but the dependent variable, a ratio of standard deviations, does not. While this inability to associate variation in the dependent variable with the independent variable leads to less precise estimates, it does not change the basic story.

Table 4 presents the results of the estimation of model (5)-(6). Several points are worth noting. First, the regressions serve as a benchmark to document that over the January 1994 to December 2006 period REIT volatility did exhibit a positive relation with stock price. The REIT stock price elasticity of variance in the Greenspan era is 2.26, with a t-statistic of 1.84. The results are consistent with the evidence of a positive relation between REIT volatility and stock price in the January 1994 to December 2006 period found in Tables 2 and 3. Second, given that the sign of λ_1 in the January 2007 to October 2012 period is positive, the negative sign of η implies that unexpected negative REIT stock returns have a larger impact on future conditional stock volatility than unexpected positive REIT stock returns. This evidence indicates that the developments during the financial crisis which led to declining REIT stock prices also led to increased REIT volatility. Third, the stock price elasticity of variance in the pre- and post-Greenspan era are insignificant. The results are consistent with a nonlinear relationship between REIT stock price and its variance.

6. Robustness Tests

In this section we present a series of robustness checks. First, it is possible that operating leverage may impact equity volatility and thereby influence or obscure the hypothesized relationship between equity volatility and the value of equity. We simplified (3) by estimating it for REITs with high versus low operating leverage. See Table 5, columns (1) and (2). Similar results to Table 2 were obtained, as again we find an inverse relation between REIT stock price and volatility for REITs with both high and low operating leverage for the subsample periods from January 1985 through December 1993 and from January 2007 through October 2012, but not over the Greenspan era from January 1994 to December 2006. Again, the results of the estimation of model (4) for REITs with both high and low operating leverage yields less precise estimates, as can be seen by the t-values reported in Table 6, columns (1) and (2). In addition, we find that our original results of estimating model (5)-(6) are unchanged when the model is estimated for REITs with high versus low operating leverage. The average REIT stock price elasticity of variance for REITs with both high and low operating leverage implies that there is a positive and significant relationship between REIT stock volatility and stock price over the subsample period January 1994 to December 2006. See Table 7, columns (1) and (2).

The second issue is that earnings growth may impact equity volatility and through this effect the parameter estimates obtained above could be biased and inconsistent. Thus, to check on the robustness of our results, we re-estimated models (3), (4), and (5)-(6) for REITs with high versus low earnings growth rates. Table 5, columns (3) and (4) present the results of the estimations of model (3). The coefficients of the price variable for REITs with both high and low earnings growth rates for the subsample periods from January 1985 to December

1993 and from January 2007 through October 2012 are negative and significant, but we again find positive and significantly different from zero estimates for REITs with both high and low earnings growth rates in the January 1994 to December 2006 period. Table 6, columns (3) and (4) present the results of the estimations of model (4). The estimates for the subsample periods from January 1985 to December 1993 and from January 2007 through October 2012 are imprecise, but the coefficients of the price ratio variable for the January 1994 to December 2006 period are positive and significantly difference from zero. Table 7, columns (3) and (4) present the results of the estimations of model (5)-(6). We find that our original results are unchanged. The average REIT stock price elasticity of variance for REITs with both high and low earnings growth rates is positive and significantly different from zero over the subsample period January 1994 to December 2006.

A third possibility is that equity volatility could be affected by market size. We partitioned our sample of equity REITs into two groups – large versus small. We re-estimated models (3), (4), and (5)-(6) for large versus small REITs to investigate this omitted variable bias. It appears that there is a negative relation between REIT equity volatility and stock price for both large and small REITs in the subsample periods from January 1985 through December 1993 and from January 2007 through October 2012, but not over the Greenspan era from January 1994 to December 2006. See Table 5, columns (5) and (6). Again, the estimation of (4) provides an ineffective means of testing the hypothesized relationship between equity volatility and the value of equity. See Table 6, columns (5) and (6). Finally, when model (5)-(6) is re-estimated for large versus small REITs, we find strong evidence of a positive and statistically significant average REIT stock price elasticity of variance over the subsample period January 1994 to December 2006, especially for large REITs. See Table 7, columns

(5) and (6). In summary, on the basis of this series of analyses to assess the robustness of the financial leverage hypothesis for REITs, we can be more confident that the conclusions regarding the relation between REIT equity volatility and stock price presented above are correct.

7. Conclusions

Taken together, our findings strongly point to a negative REIT stock price elasticity of variance before and after the Greenspan era, but not during the Greenspan era (circa 1994 to 2006). This result is not as puzzling as it might at first appear. The reasoning turns on the low and declining interest rates during the Greenspan era. As Christie (1982) and others have argued, low and declining interest rates give arise to a wealth transfer from equity holders to debt holders. This wealth transfer is reflected in the value increment of debt relative to equity, which implies an increase in financial leverage. With a strong positive association between equity variances and financial leverage, a positive relation between the variance of equity returns and equity value is expected. The latter occurs because the value of the debt and equity both increase as the interest rate falls but the debt increases more than the equity. Such behavior changes when interest rates are rising or when interest rates are more volatile and uncertain. In such circumstances, the effect of an increase in stock price on the volatility of equity is unambiguously negative.

Above, we use these arguments to provide new insight into ongoing controversies surrounding the volatility of REIT stock returns. Simple descriptive statistics show that equity REITs increased their financial leverage during the Greenspan era. Such an increase caused REITs to harbor far more risk than most people realized. But over the 1994 to 2006 period, no one would have expected a significant increase in business and financial risk, or anticipated that REIT stock prices would collapse in late 2008 and early 2009. However, as stock prices fell, equity REITs became more levered than at any other time in history and equity volatility increased (which is what the theory would predict and which is consistent with what we find).

The results reported here are valuable in what they tell us about the future rather than the past. A view prevalent in the financial press (particularly now, after the recent increase of average REIT stock return volatility in the 2007-2010 period) is that with the higher yield on REIT stocks also comes a much higher degree of risk than an investment in a lower-yielding, fixed-income security, much too high to warrant putting any investment dollars there. This argument applies especially to risk-averse investors and fixed-income managers looking to invest in REITs to boost yield because of their high dividends. Two important factors are overlooked in this assertion. The first is the fact that REITs have delevered notably since 2007. The second factor is that REIT stock prices have recovered significantly since hitting a bottom in February 2009. With a negative relation between volatility and value of equity (as suggested by our empirical results), the increase in REIT stock prices implies a decrease in equity volatility. This latter result clarifies a serious and generalized misunderstanding in the literature.

8. References

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		Stocks Sorted on:					
		DOL		Growth		Size	
	All	High	Low	High	Low	High	Low
			Panel A: Full Period, January 1985-October 2012				
StdDev	25	25	25.2	25.1	25.8	27	23.2
	(18.4)	(20.9)	(17.4)	(17.9)	(21.2)	(17.0)	(19.5)
Ret	1.02	1.27	1.11	1.3	1.07	1.57	1.17
	(5.2)	(6.1)	(5.7)	(5.7)	(6.2)	(5.9)	(5.7)
			Panel B: Subperiod, January 1985-December 1993				
StdDev	28	24.8	24.9	26.9	24.5	29.9	19.3
	(9.5)	(13.5)	(12.9)	(13.4)	(13.9)	(13.4)	(10.1)
Ret	0.97	1.53	0.91	1.3	1.14	1.74	1.34
	(3.5)	(5.2)	(5.3)	(5.6)	(5.3)	(6.1)	(4.2)
			Panel C: Subperiod, January 1994-December 2006				
StdDev	18.8	16.8	18.6	17.4	18.1	19	17
	(8.8)	(7.2)	(7.3)	(7.2)	(6.9)	(7.0)	(7.3)
Ret	1.24	1.39	1.41	1.58	1.23	1.56	1.33
	(3.8)	(3.3)	(3.7)	(3.5)	(3.6)	(3.7)	(7.0)
			Panel D: Subperiod, January 2007-October 2012				
StdDev	45.1	47.5	43.3	42.6	48.4	43.1	46.4
	(18.4)	(34.4)	(27.3)	(28.3)	(35.4)	(26.1)	(32.7)
Ret	0.48	0.37	0.54	0.51	0.4	0.79	0.33
	(9.0)	(11.1)	(9.6)	(9.6)	(11.3)	(9.5)	(10.7)

Table 1: Properties of All Equity REITs and REIT Portfolios Formed on Operating Leverage (DOL), Earnings Growth Rate (Earnings), and Market Size (Size): January 1985 to October 2012. At the end of year $t-1$, portfolios are formed on the basis of ranked values of degree of operating leverage (DOL), earnings growth rate (Earnings), and market size (SIZE). The portfolio breakpoints are determined on the basis of ranked values of the variables for all equity REIT stocks of NYSE, AMEX, and NASDAQ-listed companies that comprise the FTSE NAREIT Equity REIT index. Standard deviation (StdDev) is the time-series average of the monthly standard deviation estimated a rolling six-month window. The standard deviation is annualized by multiplying the monthly volatility by the square root of 12. Return is the time-series average of the monthly equal-weighted portfolio returns (in percent). Time-series standard deviations for these specific values are reported in parentheses.

		Summary Statistics		
Intercept	lnS	R^2	F-value	MSE
Panel A: Subperiod, January 1985-December 1993				
3.2	-0.89	0.088	10.28	0.214
(22.7)	(-3.2)			
Panel B: Subperiod, January 1994-December 2006				
2.71	0.43	0.038	6.11	0.187
(26.4)	(2.5)			
Panel C: Subperiod, January 2007-October 2012				
4.58	-1.45	0.58	93.89	0.012
(43.5)	(-9.7)			

Table 2: Estimated Regression Statistics for Model (3) for All Equity REIT Stocks. Equation estimated is given by

$$ln\sigma_S = \kappa_0 + \kappa_1 lnS + \varepsilon$$

σ_S = the standard deviation of rate of return on all equity REIT stocks estimated using a rolling six-month window. S = REIT stock price at time t. t-statistics are reported in parentheses.

Intercept	$ln(S/S_{-1})$	Summary Statistics R^2	F-value	MSE
Panel A: Subperiod, January 1985-December 1993				
1.06	-0.05	0.004	0.4	0.015
(13.3)	(-0.6)			
Panel B: Subperiod, January 1994-December 2006				
0.93	0.07	0.002	0.28	0.017
(6.6)	(0.5)			
Panel C: Subperiod, January 2007-October 2012				
1.02	-0.02	0.016	1.11	0.004
(59.5)	(-1.1)			

Table 3: Estimated Regression Statistics for Model (4) for All Equity REIT Stocks. Equation estimated is given by

$$ln(\sigma_S/\sigma_{S_{-1}}) = \beta_0 + \beta_1 ln(S/S_{-1}) + \mu$$

σ_S = the standard deviation of rate of return on all equity REIT stocks estimated using a rolling six-month window. S = REIT stock price at time t. t-statistics are reported in parentheses.

c	α	λ_1	λ_2	γ	η	b	θ	Log Likelihood
				Panel A: Subperiod, January 1985-December 1993				
0.1465	3.0567	-0.2032	–	-0.5926	1.312	0.2072	1.3146	-282.519
(2.05)	(3.57)	(-1.20)		(-2.32)	(0.94)	(1.87)	(1.15)	
				Panel B: Subperiod, January 1994-December 2006				
-0.0468	2.3629	-0.0234	-0.0705	-0.7557	2.8631	0.3698	2.262	-425.849
(-0.67)	(1.71)	(-0.23)	(-0.34)	(-3.45)	(0.37)	(4.02)	(1.84)	
				Panel C: Subperiod, January 2007-October 2012				
-0.0584	-0.2507	0.1008	-0.0658	1.0163	-6.0702	0.1202	0.1425	-237.174
(-0.45)	(-0.37)	(0.18)	(-0.19)	(10.80)	(-0.18)	(0.73)	(0.47)	

Table 4: Estimated Regression Statistics for Model (5)-(6) for All Equity REIT Stocks. Equation estimated is given by

$$r = a + bh + cr_{-1} + u$$

$$\ln h = \alpha + \gamma \ln h_{-1} + \sum_{j=1}^{2} \lambda_j z_{-j} + \theta lnS_{-1}$$

$$u \sim N(0, h), z_{-k} = [|\psi_{-k}| - (2/\pi)^{0.5} + \eta\psi_{-k}]$$

$$u_{-k} = \psi_{-k}\sqrt{h_{-k}}, \psi \sim i.i.d.N(0, 1)$$

r = monthly return on equity REITs, h = the variance of the error term u, conditioned on information available at time $t-1$, S = REIT stock price. t-statistics are reported in parentheses.

	Stocks Sorted on:					
	DOL		Growth		Size	
Variables	High	Low	High	Low	Large	Small
	Panel A: Subperiod, January 1985-December 1993					
Intercept	-6.69	-6.87	-0.29	-3.35	-4.08	-2.36
	(-8.7)	(-6.2)	(-0.3)	(-3.2)	(-7.4)	(-2.1)
lnS	-1.24	-1.18	-0.8	-1.44	-0.71	-0.14
	(-6.7)	(-4.9)	(-3.3)	(-6.1)	(-5.1)	(-0.5)
R^2	0.338	0.21	0.109	0.294	0.203	0.003
F-value	45.4	23.6	11.1	37.6	25.7	0.3
MSE	0.167	0.143	0.229	0.164	0.172	0.272
	Panel B: Subperiod, January 1994-December 2006					
Intercept	-0.91	-1.12	3.39	4.02	-1.41	-0.7
	(-4.7)	(-4.8)	(20.2)	(15.6)	(-9.3)	(-3.4)
lnS	0.33	0.18	0.2	0.35	0.13	0.39
	(5.1)	(2.8)	(3.7)	(4.7)	(2.2)	(5.7)
R^2	0.141	0.049	0.083	0.125	0.031	0.172
F-value	25.5	7.9	14	22.6	4.9	32.2
MSE	0.175	0.153	0.154	0.147	0.153	0.163
	Panel C: Subperiod, January 2007-October 2012					
Intercept	-5.17	-6.06	-0.79	-1.38	-3.73	-5.75
	(-15.5)	(-13.1)	(-2.4)	(-2.9)	(-16.8)	(-16.6)
lnS	-1.91	-1.88	-2.09	-1.78	-1.84	-2.05
	(-12.7)	(-10.9)	(-13.4)	(-10.8)	(-12.4)	(-13.8)
R^2	0.7346	0.6734	0.754	0.667	0.737	0.775
F-value	160.53	119.6	178.2	115.9	153.7	190.5
MSE	0.1079	0.1096	0.088	0.131	0.08	0.095

Table 5: Estimated Regression Statistics for Model (3) for REIT Portfolios Formed on Operating Leverage (DOL), Earnings Growth Rate (Earnings), and Market Size (Size). Equation estimated is given by

$$ln\sigma_S = \kappa_0 + \kappa_1 lnS + \varepsilon$$

σ_S = the standard deviation of rate of return on REIT stocks estimated using a rolling six-month window. S = REIT stock price at time t. t-statistics are reported in parentheses.

	Stocks Sorted on:					
	DOL		Growth		Size	
Variables	High	Low	High	Low	Large	Small
	Panel A: Subperiod, January 1985-December 1993					
Intercept	3.24	4.66	0.67	-0.02	3.07	3.22
	(1.6)	(1.8)	(0.7)	(-0.3)	(1.7)	(1.6)
$ln(S/S_{-1})$	-2.23	-3.64	0.33	1.02	-2.04	-2.21
	(-1.1)	(-1.4)	(0.4)	(1.4)	(-1.1)	(-1.1)
R^2	0.013	0.021	0.001	0.022	0.012	0.011
F-value	1.2	1.9	0.12	2.03	1.24	1.2
MSE	0.059	0.095	0.014	0.007	0.084	0.042
	Panel B: Subperiod, January 1994-December 2006					
Intercept	0.96	1.79	-1.43	-1.58	0.67	1.17
	(0.9)	(1.5)	(-1.9)	(-2.4)	(0.8)	(1.2)
$ln(S/S_{-1})$	0.05	-0.78	2.45	2.59	0.34	-0.15
	(0.1)	(-0.7)	(3.2)	(3.9)	(0.4)	(-0.2)
R^2	0.001	0.003	0.062	0.087	0.001	0.002
F-value	0.1	0.4	10.26	14.81	0.16	0.02
MSE	0.026	0.027	0.015	0.009	0.029	0.024
	Panel C: Subperiod, January 2007-October 2012					
Intercept	6.04	-41.08	0.75	0.058	-2.57	6.13
	(0.9)	(-1.6)	(3.8)	(2.2)	(0.6)	(2.1)
$ln(S/S_{-1})$	-4.74	41.1	0.26	0.43	3.1	-5.02
	(-0.7)	(1.6)	(1.3)	(1.7)	(0.7)	(-1.7)
R^2	0.01	0.042	0.029	0.045	0.004	0.05
F-value	0.55	2.57	1.74	2.76	0.55	2.91
MSE	5.03	43.56	0.004	0.005	3.093	0.926

Table 6: Estimated Regression Statistics for Model (4) for REIT Portfolios Formed on Operating Leverage (DOL), Earnings Growth Rate (Earnings), and Market Size (Size). Equation estimated is given by

$$ln(\sigma_S/\sigma_{S_{-1}}) = \beta_0 + \beta_1 ln(S/S_{-1}) + \mu$$

σ_S = the standard deviation of rate of return on REIT stocks estimated using a rolling six-month window. S = REIT stock price at time t. t-statistics are reported in parentheses.

	Stocks Sorted on:					
	DOL		Growth		Size	
Variables	High	Low	High	Low	Large	Small
Panel A: Subperiod, January 1985-December 1993						
α	0.312	0.332	0.240	-4.100	-4.313	-0.544
	(1.26)	(2.27)	(2.10)	(-2.40)	(-7.09)	(-0.65)
λ_1	-1.839	-4.836	-5.918	0.030	0.072	0.604
	(-0.48)	(-3.08)	(-3.32)	(0.34)	(1.28)	(2.29)
λ_2	0.010	0.666	1.227	–	-0.042	-0.498
	(0.04)	(3.46)	(4.28)		(-0.94)	(-1.88)
λ_3	–	–		–	0.063	0.111
					(1.08)	(0.57)
γ	0.699	0.201	0.047	0.303	0.345	0.907
	(2.38)	(0.77)	(0.16)	(1.06)	(3.96)	(6.29)
η	-34.970	-0.547	-0.134	-6.831	-1.020	-0.648
	(-0.04)	(-2.08)	(-0.76)	(-0.34)	(-0.82)	(-1.60)
b	0.522	-0.029	-0.756	4.238	5.341	0.136
	(0.58)	(-1.04)	(-2.07)	(0.70)	(32.35)	(0.29)
c	0.001	–	0.040	0.640	0.444	0.172
	(0.01)		(2.93)	(2.11)	(2.18)	(1.29)
θ	0.522	0.796	–	0.001	0.026	–
	(0.58)	(1.39)		(0.01)	(0.25)	
Log Likelihood	157.5	155.2	160.0	146.2	202.1	159.4
Panel B: Subperiod, January 1994-December 2006						
α	-6.796	-12.247	-10.412	-8.283	-7.596	-12.352
	(-3.74)	(-9.23)	(-2.68)	(-3.06)	(-3.92)	(-9.31)
λ_1	-0.211	0.448	0.069	0.127	0.095	0.008
	(-1.28)	(2.24)	(0.55)	(0.70)	(0.58)	(0.06)
λ_2	-0.491	–	-0.376	-0.711	-0.652	-0.210
	(-2.26)		(-1.30)	(-3.26)	(-2.75)	(-0.95)
γ	0.141	-0.581	0.064	0.271	0.172	-0.681
	(0.59)	(-2.97)	(0.18)	(1.08)	(0.80)	(-3.69)
η	0.867	0.280	0.746	0.740	0.778	0.933
	(2.85)	(1.08)	(1.34)	(2.43)	(2.57)	(1.17)
b	0.384	0.479	0.327	0.180	0.236	0.174
	(4.34)	(5.05)	(0.78)	(0.80)	(1.07)	(0.34)
c	0.082	-0.008	0.036	-0.013	0.029	-0.026
	(1.36)	(-0.10)	(0.44)	(-0.18)	(0.46)	(-0.33)
θ	0.608	0.614	0.648	0.487	0.847	0.437
	(3.63)	(2.18)	(1.97)	(2.78)	(3.26)	(1.52)
Log Likelihood	307.4	320.2	306.5	316.9	322.4	299.9

Table 7: Estimated Regression Statistics for Model (5)-(6) for REIT Portfolios Formed on Operating Leverage (DOL), Earnings Growth Rate (Earnings), and Market Size (Size).

	Stocks Sorted on:					
	DOL		Growth		Size	
Variables	High	Low	High	Low	Large	Small
	Panel C: Subperiod, January 2007-October 2012					
α	-4.553	-1.929	-3.845	-0.838	-4.822	-4.613
	(-2.98)	(-0.73)	(-0.66)	(-0.33)	(-1.81)	(-1.43)
λ_1	0.034	-0.327	-0.013	0.205	-0.155	0.107
	(0.21)	(-1.37)	(-0.08)	(0.62)	(-1.11)	(0.51)
λ_2	0.328	0.479	0.594	–	0.462	0.641
	(1.18)	(0.82)	(1.36)		(1.80)	(1.31)
λ_3	–	-0.088	-0.074	–	-0.144	0.036
		(-0.22)	(-0.27)		(-0.79)	(0.12)
γ	0.103	0.601	0.226	0.845	0.019	0.085
	(0.86)	(1.17)	(1.11)	(4.60)	(0.16)	(1.40)
η	-1.047	-0.914	-1.121	-1.144	-1.093	-1.040
	(-0.88)	(-1.50)	(-1.14)	(-0.51)	(-1.86)	(-0.99)
b	1.965	3.202	1.045	0.591	1.517	0.916
	(4.38)	(1.35)	(1.84)	(0.82)	(3.00)	(1.82)
c	0.284	0.085	0.228	0.076	0.245	0.282
	(1.71)	(0.27)	(2.41)	(0.30)	(2.94)	(1.95)
θ	0.014	0.014	0.009	0.013	0.005	0.008
	(0.03)	(0.05)	(0.01)	(0.04)	(0.01)	(0.01)
Log Likelihood	65.4	61.8	60.7	64.0	61.1	67.5

Table 7 – Continued. Equation estimated is given by

$$r = a + bh + cr_{-1} + u$$

$$\ln h = \alpha + \gamma \ln h_{-1} + \sum_{j=1}^{3} \lambda_j z_{-j} + \theta lnS_{-1}$$

where $u \sim N(0, h)$, $z_{-k} = [|\psi_{-k}| - (2/\pi)^{0.5} + \eta\psi_{-k}]$, $u_{-k} = \psi_{-k}\sqrt{h_{-k}}$, $\psi \sim i.i.d.N(0,1)$, r = monthly return on equity REITs, h = the variance of the error term u, conditioned on information available at time $t-1$, S = REIT stock price. t-statistics are reported in parentheses.

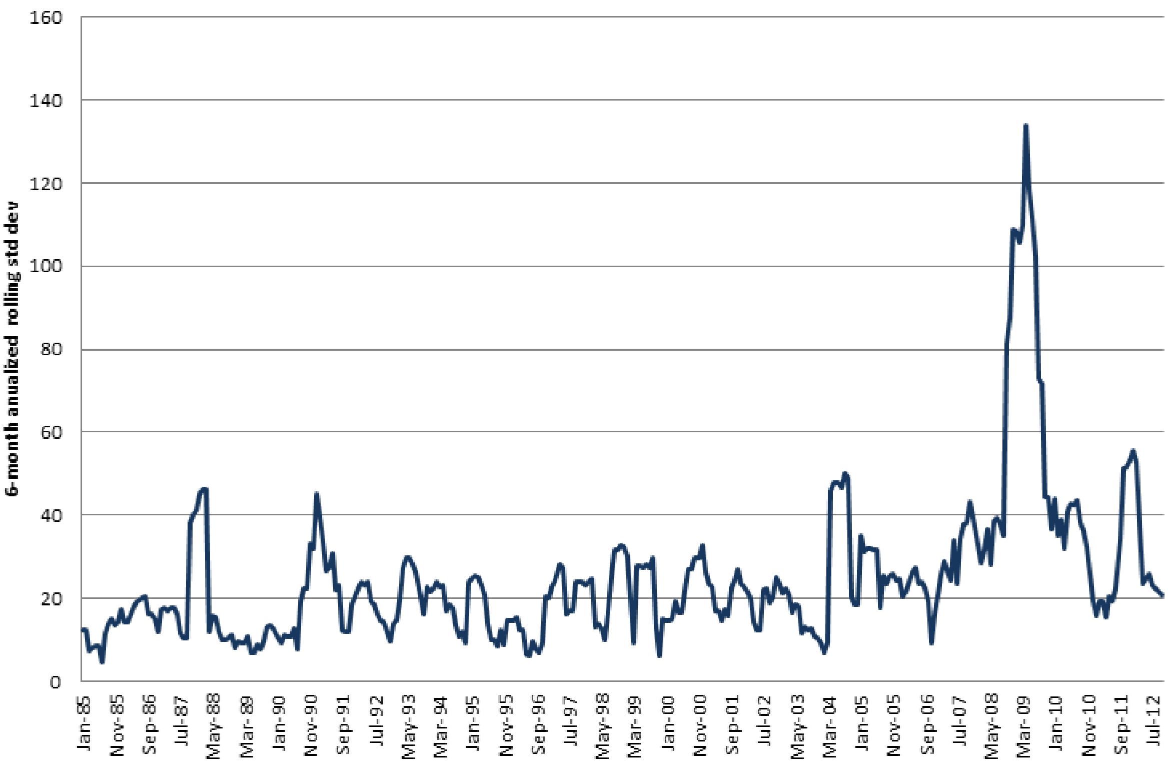

Figure 1: Equity REIT Stock Price Volatility. Vertical axis: Rolling 6-month Standard Deviation in Equity REIT Stock Prices. Horizontal axis: Month. Sample period is January 1985 through October 2012.

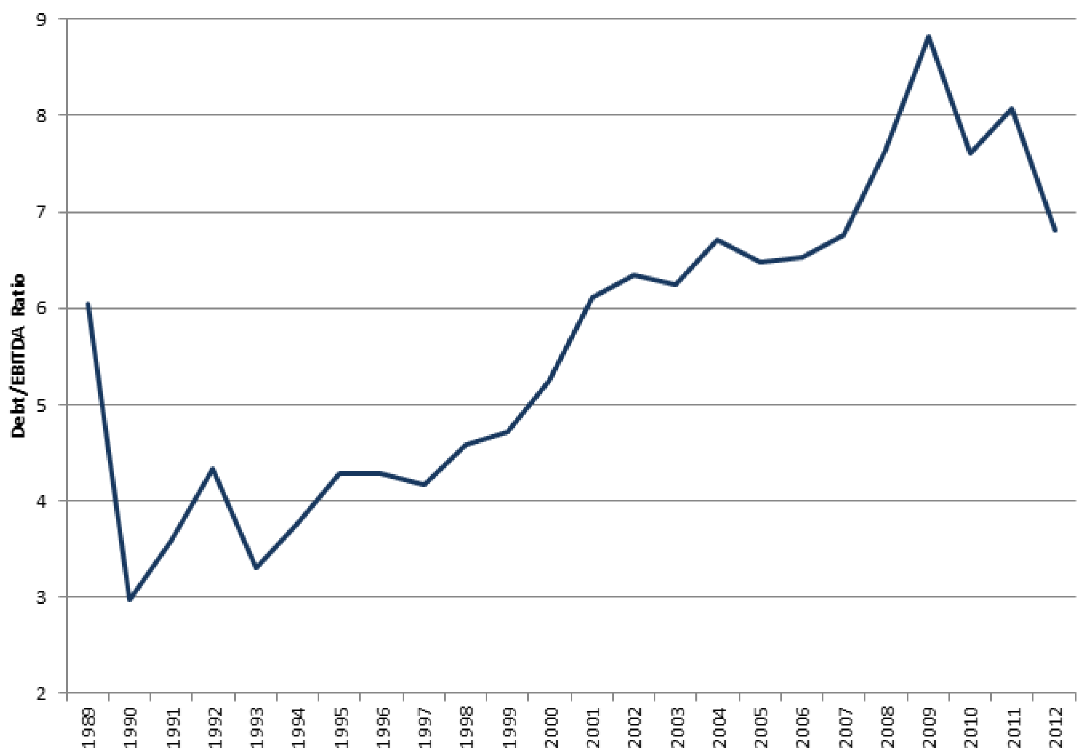

Figure 2: Plot of Debt-to-EBITDA Ratio for Equity REITs, 1989-2012. Vertical axis: Debt-to-EBITDA ratio. Horizontal axis: Year. Sample period is 1989 through December 2012.

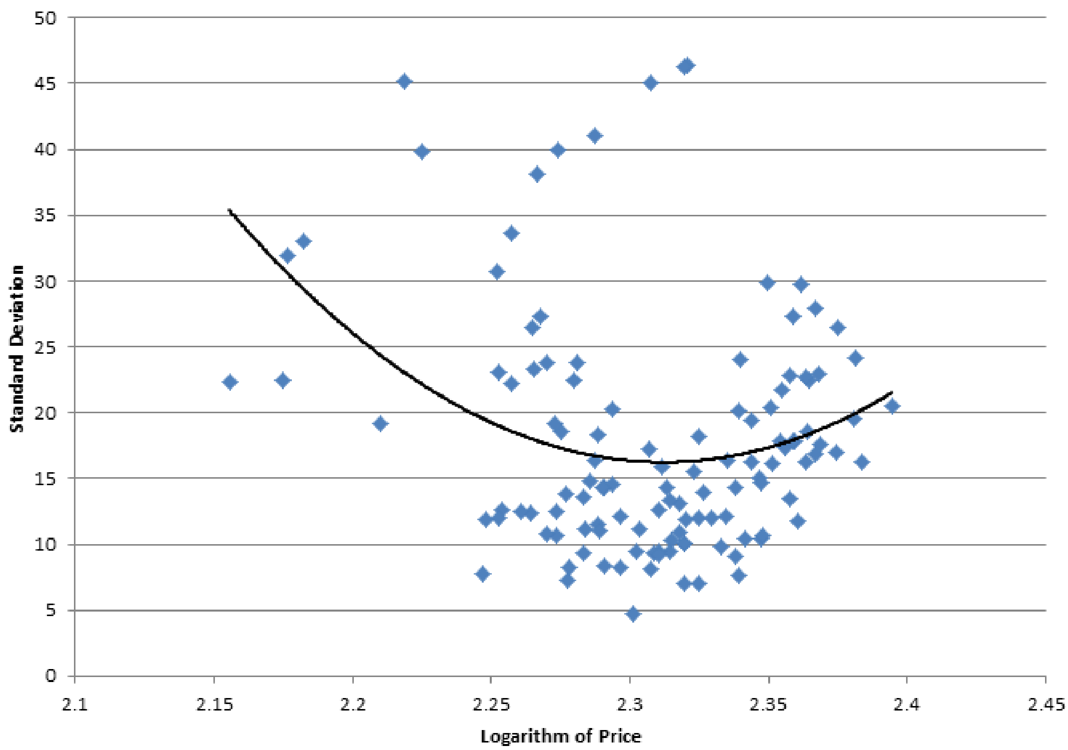

Figure 3: Plot of Equity REIT Stock Price Volatility vs. Logarithm of Price, 1985-1993. Vertical axis: Rolling 6-month Standard Deviation in Equity REIT Stock Prices. Horizontal axis: Logarithm of Price. Sample period is January 1985 through December 1993.

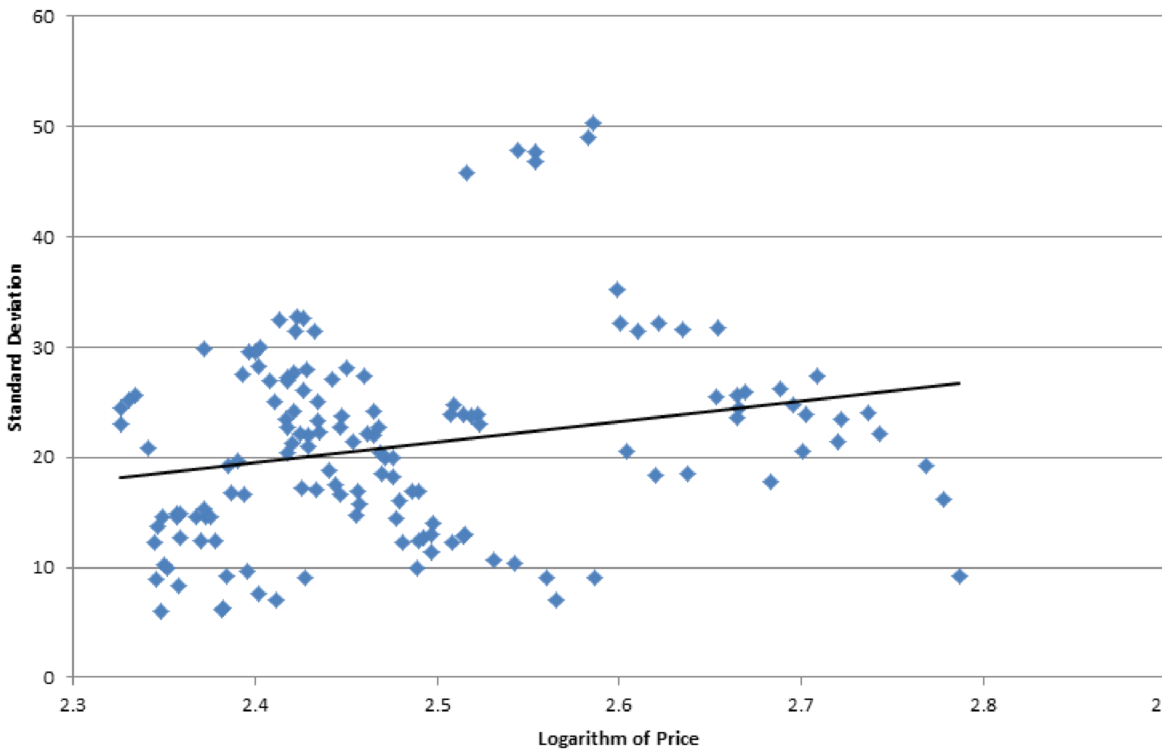

Figure 4: Plot of Equity REIT Stock Price Volatility vs. Logarithm of Price, 1994-2006. Vertical axis: Rolling 6-month Standard Deviation in Equity REIT Stock Prices. Horizontal axis: Logarithm of Price. Sample period is January 1994 through December 2006.

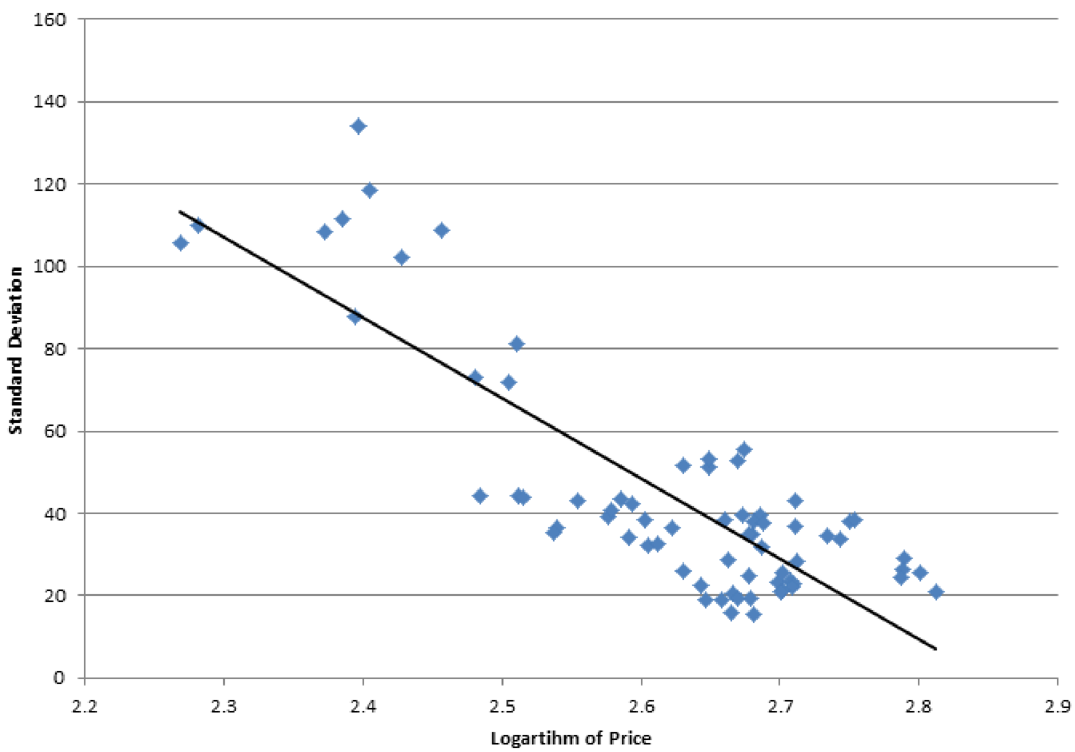

Figure 5: Plot of Equity REIT Stock Price Volatility vs. Logarithm of Price, 2007-2012. Vertical axis: Rolling 6-month Standard Deviation in Equity REIT Stock Prices. Horizontal axis: Logarithm of Price. Sample period is January 2007 through October 2012.