Why Are REITS Currently So Expensive?

Stijn Van Nieuwerburgh[*]

NYU, NBER, & CEPR

August 22, 2017

Abstract

For the last several years, the price of listed real estate stocks has been unusually high relative to dividends. I explore whether low interest rates or low risk premia can account for the high valuation ratios and find that they cannot. Lower interest rates have been offset by rising risk premia to keep expected returns close to average. Instead, the market has priced in future income growth on commercial properties that is far above the growth rates seen in the data. High implied growth rates hold across traditional REIT sectors, but are less extreme for non-traditional REIT sectors. Income growth expectations are also less extreme for an index of international listed real estate. Investors who ignore the recent increase in interest rate risk that we document would need to hold lower, but still unusually large income growth expectations.

Keywords: commercial property, REITS, real estate risk and return, real estate bubble
JEL: R3, R33, G12

This article is forthcoming in the journal *Real Estate Economics*.

1   Introduction

The low-interest rate environment of the post-financial crisis era has been blamed for high valuations on financial assets and real estate assets alike. Figure 1 plots the price-dividend ratio on the NAREIT U.S. All Equity REIT index. For over a quarter century, public real estate companies traded in a fairly narrow range of price-dividend ratios between 12 and 18. The commercial real estate boom of 2004-2007 pushed valuation ratios outside this range, as high as 27.5 in the first quarter of 2007. A sharp correction in the last quarter of 2008 and the first quarter of 2009 halved property valuations and brought them to record lows. Valuation ratios of public real estate companies recovered sharply in the long expansion that followed since then. By the first quarter of 2010, REITS were trading back above pre-crisis peak levels. Valuations have remained in the 24.5-30.5 range ever since. This paper investigates what can explain the high valuation ratios on REITS.
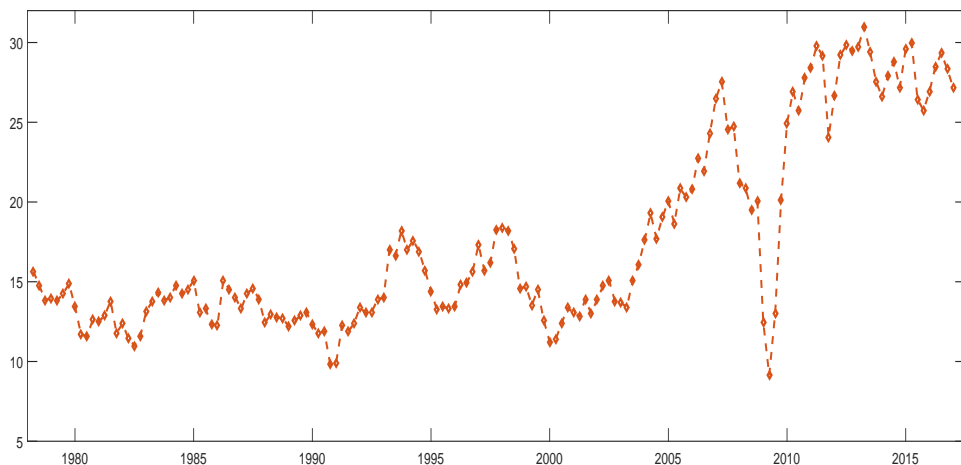

Figure 1: Real Estate Valuations

The figure plots the price-dividend ratio on the NAREIT All Equity REIT index. Monthly dividends are constructed from cum-dividend and ex-dividend returns, and monthly dividends are added up over twelve months to construct annual dividends. The sample period is January 1972–December 2016.

We use the celebrated present-value relationship of Campbell and Shiller (1989) to connect the evolution of the price-dividend ratio of REITS to the evolution of expected returns and expected dividend growth rates. The logic of the model is straightforward. High valuation ratios, like the ones we have observed over the past seven years, must be due to high expected dividend growth, low expected returns, or a combination of both. Low expected returns can reflect either a low time value of

money –low interest rates– or a low risk premium. The risk premium itself can be low either because the quantity of risk of REITS is low or the price per unit of risk is low.

We propose a parsimonious model for the expected return on REITS which stipulates that investors require risk compensation for exposure to the overall stock market, capturing business cycle risk, and for exposure to interest rate risk. Our preferred risk model adds compensation for size, value, and momentum risk. These factors are commonly used in empirical asset pricing (following Fama and French, 1992; Carhart, 1997, and many others) as well as in the modeling of REIT returns (e.g., Peterson and Hsieh, 1997; Karolyi and Sanders, 1998; Anderson, Clayton, Mackinnon, and Sharma, 2005). We show that the resulting five-factor model explains a large fraction of the variation in REIT returns. It also fits the data well in that it results in a zero abnormal return over the full 1972–2016 sample. The average realized return on REITS and the unconditional expected return are not different from each other.

To capture dynamics in the expected return, we allow both the risk-free interest rate and the exposures (betas) of REITS with respect to the five factors to fluctuate over time. We keep the factor risk premia constant since it is difficult to reliably estimate average returns over short samples. The estimation reveals substantial variation in the exposure of REITS to the underlying risk factors, especially during the last 15 years of the sample. First, the equity beta rises sharply during the crisis, reflecting the fact that the boom and bust in the U.S. economy was intimately linked to residential and commercial real estate (e.g., Favilukis, Ludvigson, and Van Nieuwerburgh, 2017; Mian and Sufi, 2011; Davis and Van Nieuwerburgh, 2014, for a review of the literature). Stock betas of real estate fall towards the end of the sample as the crisis disappears in the rear view mirror, but remain elevated by historical standards.

Second, we find a sharp rise in the interest rate risk of REITS over the last decade. The bond beta surges from zero pre-2005 to 1.5 at the end of our sample in December 2016. With a bond beta of 1.5, a 100 basis point increase in 10-year bond yields results in a 14% drop in REIT prices. The rising bond beta reflects a rise in the univariate correlation between REIT and bond returns, which in the last part of the sample far exceeds the rise in the correlation between overall stock and bond returns. It also reflects a rise in the ratio of REIT volatility to bond volatility. The bond beta is estimated to be larger once the other risk factors are included in a multi-variate setting. This is due

to the offsetting effects of rising rates on REIT cash-flow growth and discount rates. Once the effect on cash flow growth is soaked up by the stock market factors, the rising interest rate risk of REITS becomes even more apparent.

A first main conclusion from this paper, then, is that the expected return on REITS has not declined very much at all over the past decade, despite the massive fall in the risk-free interest rate. The growing stock and bond risk premia have surged to offset this decline.

Since expected returns were not unusually low, the high valuation ratios of the past seven years must have been due to high dividend growth expectations. We use the present-value model to quantify these growth expectations, assuming that in the long-run the present-value relationship must be respected. Our second main finding is that U.S. REIT investors price in dividend growth expectations of 20-to-30% per year over the 2010-2016 period. Since dividend growth expectations are persistent, the annual expected growth rate implies cumulative growth rates of 45-60% over the next several years.

The implied dividend growth is a simple but useful metric of relative value. Since it controls for the systematic risk of REITS, it can be interpreted as a summary measure of how expensive REITS are relative to stocks and bonds. Our exercise suggests growth expectations that are far above historical average growth rates. By the logic of the present-value model, a reversion of growth expectations towards historical norms will result in a drop in REIT prices, unless it is offset by a simultaneous decrease in REIT risk premia.

We investigate how sensitive our implied dividend growth metric is to the choice of risk model. Having already considered both a two- and five-factor model, we investigate two simple alternatives used by practitioners. The first one sets the expected return on REITS equal to the 10-year Treasury yield plus a constant spread. We choose the spread to deliver the same long-run expected return as in our baseline model. The second simple model ignores the recent rise in the equity and bond risk exposure of REITS. It adds the historical average stock and bond risk premia (a spread of 3.65%) to the one-month interest rate to arrive at the expected return. While these models result in reductions in the implied dividend growth, the changes are small, and our conclusions remains unaffected. The current implied dividend growth, even under these alternative risk models, remains far above the historical average. Along the same lines, we explore whether a permanent change in the long-run mean of the price-dividend ratio (Lettau and Van Nieuwerburgh, 2008), induced by a permanent change in

interest rates or factor risk premia, affects our conclusions. We find that it does not. Finally, we ask whether REITS may be a hedge for macro-economic tail risk or the risk of disruptions in financial intermediation. We find that they are not. If anything, REITS perform poorly when this tail risk materializes. Accounting for this risk further increases the implied dividend growth.

Next, we turn to the cross-section. We uncover interesting differences in valuations and risk exposures across REIT sectors. There is a wide range of equity betas reflecting the varying degree of business cycle exposure. The REIT sectors also show large differences in interest rate risk exposure. Bond betas are low for hotel and apartment REITS, where the typical rental contracts are short-term in nature, and high for industrial and health care REITS, where typical leases are long-term. The data are consistent with a duration-based explanation of the bond risk premium pattern. A 100 basis point rise in long-term rates would lower the prices of hotel REITS by less than 1% but lower prices of Industrial REITS by more than 7%, all else equal. Using the risk model and sector-specific valuation ratios, we back out the dividend growth expectations of REIT investors. We find large differences in the last seven years of the sample. On one end of the spectrum are apartment and office REITS, which have 25% annual expected growth. On the other end of the spectrum are Health care and Self-storage REITS which price in growth of only 5-10% per year.

Finally, we turn to the international evidence to investigate whether the high valuation ratios are a U.S.-specific phenomenon. We use a global core real estate REIT index from MSCI/IPD, which combines public real estate securities from 24 countries. Price-dividend ratios of global and U.S. REITS are very similar. However, we estimate a lower risk premium for the global REIT index. Thus, much lower implied growth rates are needed to justify the same valuation ratio. In mid-2015, implied dividend growth in global REITS is around 5% per year, 15% points below the level for the U.S. The elevated growth expectations (and concomitant risks of reversal) are substantially more pronounced for the U.S.

The rest of the paper is organized as follows. Section 2 sets up the present-value model. Section 3 discusses the risk model and implied growth predictions for the U.S. REIT index. Section 4 turns to the cross-section of REIT sectors. Section 5 discusses the global REIT index and compares the results to the U.S. Section 6 discusses implications for non-listed real estate. Section 7 concludes.

2　Valuation Framework

2.1　Present-Value Model

Let P_t be the price of a risky asset, D_{t+1} its (stochastic) cash-flow, and R_{t+1} the cum-dividend return:

$$R_{t+1} = \frac{P_{t+1} + D_{t+1}}{P_t}.$$

We can log-linearize the definition of the cum-dividend return to obtain:

$$r_{t+1} = k + \Delta d_{t+1} + \rho\, pd_{t+1} - pd_t,$$

where all lowercase letters denote natural logarithms and $pd_t = p_t - d_t = -dp_t$. The constants k and ρ are functions of the long-term average log dividend-price ratio. Specifically,

$$\rho = \frac{\exp(\overline{pd})}{1 + \exp(\overline{pd})}, \qquad k = \log(1 + \exp(\overline{pd})) - \rho\overline{pd}. \tag{1}$$

By iterating forward on the return equation, adding an expectation operator on each side, and imposing a transversality condition (i.e., ruling out rational bubbles), we obtain the present-value model of Campbell and Shiller (1989):

$$pd_t = \frac{k}{1-\rho} + E_t\left[\sum_{j=1}^{+\infty} \rho^{j-1}\Delta d_{t+j}\right] - E_t\left[\sum_{j=1}^{+\infty} \rho^{j-1} r_{t+j}\right]. \tag{2}$$

A high price-dividend ratio must reflect the market's expectation of (i) higher future dividend growth, (i) lower future returns on REITS (i.e., future price declines), or (iii) a combination of the two.

This equation also holds unconditionally:

$$\overline{pd} = \frac{k}{1-\rho} + \frac{\bar{g}}{1-\rho} - \frac{\bar{x}}{1-\rho}, \tag{3}$$

where $\bar{g} = E[\Delta d_t]$ and $\bar{x} = E[r_t]$ are the unconditional expected dividend growth and expected return, respectively. Equation (3) can be rewritten to deliver the well-known Gordon Growth model (in logs)

by plugging in for k:

$$\log\left(1 + \exp\overline{pd}\right) - \overline{pd} = \overline{x} - \overline{g}. \tag{4}$$

The left-hand side variable is approximately equal to the long-run dividend yield $\overline{D/P}$.

Subtracting equation (3) from (2), we obtain:

$$pd_t - \overline{pd} = E_t\left[\sum_{j=1}^{+\infty}\rho^{j-1}\left(\Delta d_{t+j} - \overline{g}\right)\right] - E_t\left[\sum_{j=1}^{+\infty}\rho^{j-1}\left(r_{t+j} - \overline{x}\right)\right]. \tag{5}$$

Price-dividend ratios exceed their long-run average when dividend growth expectations are above their long-run average or expected returns are below the long-run expected return.

Since REITS invest in cash-flow producing properties and must pay out most of the net operating income (NOI) from those buildings to preserve their REIT status, we can think of the dividend growth equivalently as NOI growth and of the dividend-price ratio as the cap rate, the ratio of NOI to price.[1] Below-average cap rates then reflect either above-average NOI growth or below-average expected returns.

Campbell, Davis, Gallin, and Martin (2009) were the first to apply the present value model to real estate. They studied a variance decomposition of the residential house price-rent ratio in the U.S.

Expected Dividend Growth In what follows, we assume that expected dividend growth on REITS follows an autoregressive process. Denote expected dividend growth by g_t:

$$g_t \equiv E_t[\Delta d_{t+1}]$$

and assume an AR(1) for g_t:

$$g_t = (1 - \rho_g)\overline{g} + \rho_g g_{t-1} + \varepsilon_t^g \tag{6}$$

---

[1]REITS are allowed to depreciate their assets so that earnings before depreciation exceed dividends. Historically, REITS have paid out 72% of earnings before depreciation (Commercial Real Estate Finance Council). If this payout share is constant, as it approximately is in the data, the growth rate of dividends equals that of NOI.

Under this assumption, the dividend growth term in equation (5) can be written as a function of the current period's expected dividend growth in excess of the long-run mean:

$$E_t \left[\sum_{j=1}^{+\infty} \rho^{j-1} \left(\Delta d_{t+j} - \overline{g} \right) \right] = \frac{1}{1 - \rho \rho_g} (g_t - \overline{g}). \tag{7}$$

Expected Returns   Similarly, define expected returns on REITS by x_t

$$x_t \equiv E_t[r_{t+1}]$$

and assume an AR(1) for x_t following Lettau and Van Nieuwerburgh (2008); Binsbergen and Koijen (2010); Koijen and van Nieuwerburgh (2011):

$$x_t = (1 - \rho_x)\overline{x} + \rho_x x_{t-1} + \varepsilon_t^x \tag{8}$$

Under this assumption, the return term in equation (5) can be written as a function of the current period's expected return in excess of the long-run mean:

$$E_t \left[\sum_{j=1}^{+\infty} \rho^{j-1} \left(r_{t+j} - \overline{x} \right) \right] = \frac{1}{1 - \rho \rho_x} (x_t - \overline{x}). \tag{9}$$

Implied Dividend Growth Expectations   With equations (7) and (9) in hand, we can solve equation (5) for the current-period beliefs about dividend growth:

$$g_t = \overline{g} + (1 - \rho \rho_g) \left(pd_t - \overline{pd} \right) + \frac{1 - \rho \rho_g}{1 - \rho \rho_x} (x_t - \overline{x}). \tag{10}$$

It depends on long-run expected dividend growth (first term), the deviation of the price-dividend ratio from its long-run mean (second term), and the deviation of expected returns from their long-run mean (third term). Long-run expected dividend growth $\overline{g}$ is obtained from (3) given $\overline{pd}$ and $\overline{x}$.

2.2 Expected REIT returns

The expected return on any asset reflects compensation for the time value of money and compensation for risk. The risk compensation may contain multiple components, representing compensation for the various sources of systematic risk. We follow a long tradition in empirical finance and express the log expected excess return on REITS as a linear function of the product of risk factor exposures and market prices of risk. To obtain the expected return, we add the one-period risk-free interest rate r_t^f:

$$x_t = E_t\left[r_{t+1}\right] = r_t^f + \beta_t \Lambda. \tag{11}$$

When all risk factors are traded, the market prices of risk in the vector Λ must equal the unconditional expectation of the excess returns on the factors. Since expected excess returns on the factors are hard to estimate on the typical samples of data available, we estimate them as the full-sample average of realized excess returns. We do robustness with respect to this assumption in Section 2.5. In contrast, we allow for the factor exposures of REITS to vary over time since covariances and variances, and therefore betas, are easier to estimate over short samples. We use 60-month rolling-windows to do so.

2.2.1 Two-Factor Model

The most basic and natural model of risk for REITS is one with a stock market and a bond market factor. Intuitively, the stock market exposure measures how sensitive REITS are to changes in economic activity, while the bond market beta captures sensitivity to changes in interest rates.

We denote by rx_{t+1}^s the excess return on the stock market, the monthly value-weighted excess return on all NYSE, NASDAQ, and AMEX stocks from Ken French's data library, and by rx_{t+1}^b the excess return on the bond market, measured by the monthly excess return on 10-year constant maturity Treasury bonds, from CRSP (via WRDS). The 10-year rate is arguably the most salient rate for real estate investors. The risk-free rate is the one-month T-bill rate from Ibbotson (via Ken French). The full sample runs from January 1972 until December 2016, which contains 540 months of data. We also explore a sample which covers the modern REIT era and runs from January 1994 until December 2016 (276 months). During the latter sample, REIT returns are available for the various REIT sectors.

8

Unconditional Expected Returns The unconditional risk factor model estimates full-sample betas using the entire time-series of log excess returns on equity REITS, rx^{reit}, stocks, and bonds

$$rx_t^{reit} = \alpha + \beta^s rx_t^s + \beta^b rx_t^b + e_t \tag{12}$$

Column (2) of Table 1 shows the results from this regression, reporting both point estimates and Newey-West t-statistics. It shows that the stock market beta of REITS is 0.64, which implies that a 1% point move in the market excess return is associated with an average change in REIT returns of 0.64% points. That is, REITS behave like defensive, utility-like stocks in terms of their stock-market exposure. The stock market exposure of REITS is precisely measured with a t-statistic of 9.9.

The bond market exposure of REITS is estimated to be 0.08. However, it is imprecisely estimated. The near-zero interest rate risk of REITS is surprising in light of the prominence of interest rates in discussions of commercial real estate return prospects. We show below that this full-sample average hides interesting variation over time, and is much larger in the last part of the sample.

The last row of the table reports the unconditional expected return, formed as the sum of the average risk-free rate plus the equity risk premium plus the bond risk premium of REITS:

$$\overline{x}^{2f} = E\left[r_{t+1}\right] = E[r_t^f] + \beta^s \Lambda^s + \beta^b \Lambda^b, \tag{13}$$

where we measure $(\Lambda^s, \Lambda^b) = (E[rx_{t+1}^s], E[rx_{t+1}^b])$ as the full-sample averages of the log excess returns. The equity risk premium Λ^s is 5.2% per year while the bond risk premium Λ^b is 2.4% per year. Given the estimated stock beta of 0.66, REIT investors earn compensation of 3.4% (0.66 × 5.2%) per year for exposure to stock market risk. The compensation for interest rate risk is only 0.2%. The time value of money compensation $E[r_t^f]$ over the full sample period is 4.7%. Adding up these three components leads to the expected return, or cost of capital, of 8.36% that is shown in the last row of the table.

The first row of Table 1 reports the full-sample alpha. It is estimated at 2.92% per year, but is not statistically different from zero (t-statistic of 1.34). Over the full sample period, REITS have earned average returns of 11.28%, 2.92% higher than the 8.36% they should have earned according to the two-factor model. This outperformance may well reflect compensation for sources of systematic risk that are missing from the simple two-factor model. Indeed, stock and bond excess returns explain

9

only 35.6% of the variation in REIT excess returns, leaving nearly 2/3 of return variation in listed commercial real estate returns unaccounted for. We turn to a richer five-factor model below.

For comparison, Column (1) of Table 1 reports the standard CAPM model which only contains a stock market factor. It explains nearly the same amount of variation in REIT returns as the two-factor model over the full sample and the equity market beta of REITS is the same as well. The CAPM alpha is 20 basis points per year higher.

Table 1: **Analyzing Equity REIT Performance: Unconditional Factor Models**

The dependent variable is the excess return on the equity REIT index. The independent variables are listed in the main text. The first row reports the intercept α, the other rows report risk factor exposures β. The t-statistics are computed using Newey-West standard errors with one lag. The last but one row reports the R^2 of the regression. The last row reports the expected return according to the regression model. It includes the risk-free rate and excludes the alpha. The data are monthly from January 1972–December 2016 in Panel A and from January 1994–December 2016 in Panel B.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	A: Full Sample 1972-2016					B: Modern REIT Sample 1994-2016				
α	3.12	2.92	−0.65	−0.09	−1.02	2.90	1.87	−1.11	−0.60	−1.82
t-stat	1.43	1.34	−0.32	−0.04	0.54	0.77	0.48	−0.34	−0.18	−0.58
β^s	0.66	0.66	0.69	0.67	0.69	0.74	0.77	0.79	0.75	0.82
t-stat	9.37	9.16	10.44	10.59	12.10	5.54	5.80	7.77	7.28	9.01
β^b		0.09	0.20	0.21	0.18		0.31	0.44	0.48	0.43
t-stat		0.93	2.93	2.64	2.16		1.44	2.78	3.05	2.64
β^{smb}			0.41	0.41	0.45			0.44	0.45	0.49
t-stat			7.72	7.90	8.41			5.46	5.59	5.44
β^{hml}			0.57	0.55	0.59			0.73	0.69	0.68
t-stat			6.40	6.39	4.50			6.27	6.15	3.79
$\beta^{mom/op}$				−0.06	0.17				−0.10	0.16
t-stat				−1.18	2.27				−1.45	1.41
β^{inv}					−0.07					0.00
t-stat					−0.51					0.02
R^2	36.58	36.75	52.25	52.56	52.82	32.54	33.61	52.17	52.85	52.47
Exp. ret.	8.16	8.36	11.93	11.36	12.29	7.20	8.24	11.21	10.70	11.93

Panel B of Table 1 estimates the unconditional expected return models for REITS on the modern REIT sample, which starts in January 1994. This is an often-used sample in REIT research. Studying

this subsample allows us to detect whether the relationship between REITS, stocks, and bonds has changed at low frequencies. In this exercise, the market prices of risk are estimated as the average excess stock and bond returns over the post-1994 sample. Column (7) shows a higher equity market beta of REITS of 0.77, which is precisely estimated. The reason for the higher stock beta will become apparent in the discussion below. Arguably more dramatic is the rise in the interest rate risk exposure of REITS. The 10-year Treasury return beta is 0.31 in the 1994–2016 sample, more than three times its value in the full sample. The two-factor model explains a similar 1/3 of variation in REIT returns in the modern REIT era. The unconditional expected return, computed from equation (12) with (Λ^s, Λ^b) equal to the average factor excess returns measured over the subsample 1994–2016, is 8.24% per year.

Conditional Expected Returns   The conditional two-factor model estimates conditional betas in month t from a regression of excess REIT returns on excess stock and bond returns between months t and t-59:

$$rx_{t-j}^{reit} = \alpha_t + \beta_t^s rx_{t-j}^s + \beta_t^b rx_{t-j}^b + e_{t-j}, \quad \forall j \in \{0, \cdots, 59\} \tag{14}$$

The top left panel of Figure 2 plots the stock market beta of REITS. The stock-market risk of REITS varies substantially over time; the equity beta has a time series standard deviation of 0.42. In the initial decades, the stock beta of REITS is fairly stable and hovers in a narrow range around 2/3. Between the 5-year period ending in 1995 and the 5-year period ending in 2005, the stock beta falls dramatically to about 0.2. REIT dynamics become largely disconnected from stock returns over this period during. Indeed, the R^2 value from the factor regression plotted in the bottom right panel of the figure shows a massive drop from above 50% in the early 1990s and before to less than 10% in the 5-year period ending in 2005. This was a boom era for REITS (and commercial real estate more broadly) while the technology sector drove much of the dynamics in the overall stock market.

Both stock betas and R^2 rise dramatically over the 2005-2013 period. From February 2007 until February 2009, REIT and stock returns sell off together. Starting in March 2009, they both rebound together. The stock beta of equity REITS peaks at 1.75 for the 5-year periods that end around 2009-10. To better understand the equity beta dynamics, recall that (in a univariate setting) the equity beta of REITS is the product of the correlation between the excess returns of REITS and stocks and the ratio of the volatility of REITS to the volatility of stocks. Figure 3 plots the annualized volatilities
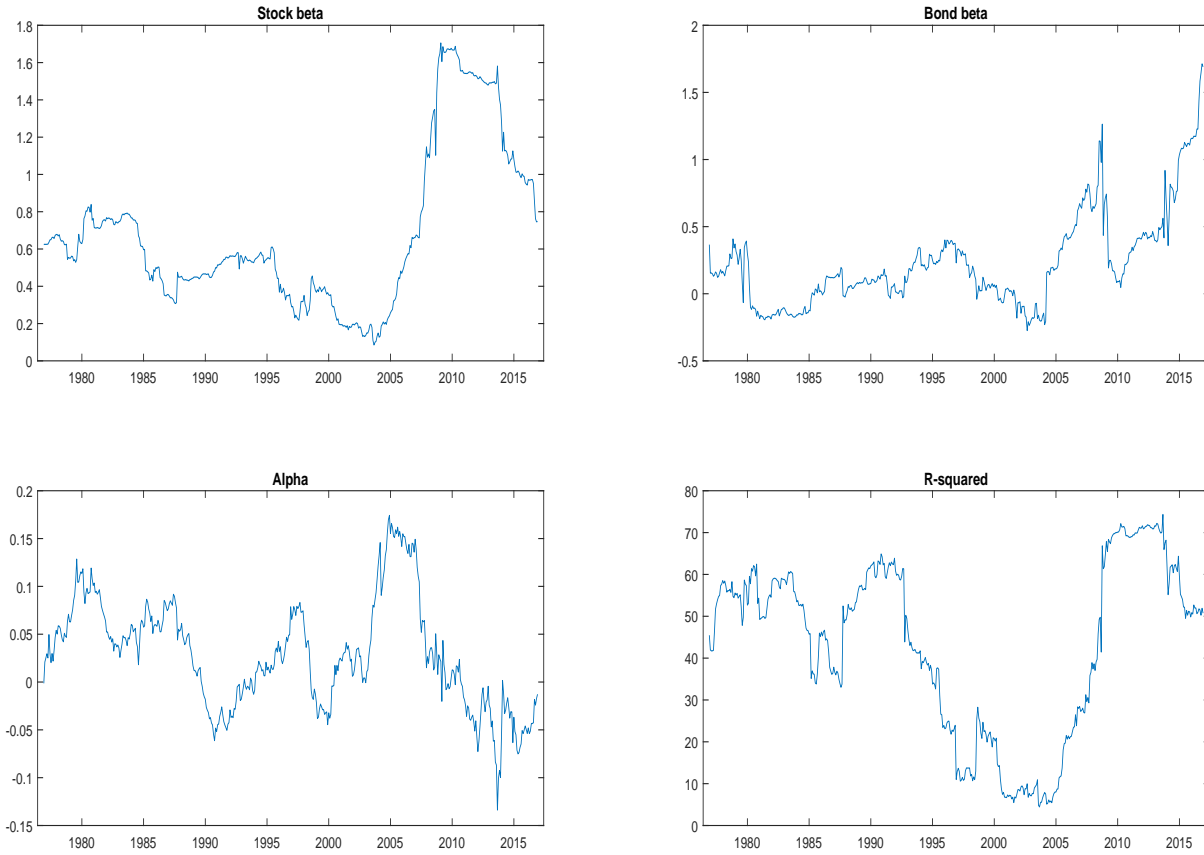
Figure 2: Time-Varying Betas for REITS in Two-Factor Model

The top row of figure plots the betas of equity REITS to the stock market excess return and the 10-year bond market return. The bottom panel plots the abnormal return or alpha and the regression R^2. Each observation (month) in the four panels reflects the estimation output of the multivariate regression (14) using 60 months of data ending in that month. The sample period is January 1972–December 2016. The first observation is for December 1976, using 60 months of data from January 1972 until December 1976.

of the excess returns on REITS, stocks, and bonds in the top row, as well as their pairwise correlations in the bottom row. The sharp rise in the equity beta of REITS arises because the correlation rises from 0.2 to 0.8, and because the volatility of REITS rises faster than the volatility of stocks. In fact, the volatility of stocks is still falling during the initial part of the crisis while that of REITS is already rising. And even when the volatility of stocks picks up, it never rises beyond 20% while that of REITS rises to 35%. The high correlations and betas are intuitive: the financial crisis and the associated stock market rout were intimately related to real estate.

At the end of the sample, the equity beta of REITS starts to fall again. Both the correlation and the volatility ratio decline. While both volatilities fall sharply, REIT volatility normalizes from a much higher level than stock market volatility. At the end of the sample in December 2016, the equity beta of REITS stands at 0.75. This estimate reflects the co-movement of REITS and stocks over the 2012-2016 period.

The bond beta of REITS is plotted in the top right panel of Figure 2. In the initial three decades from 1972-2002, the bond beta fluctuates in a narrow range between -0.2 and +0.2. Figure 3 shows that the correlation between REIT and bond returns was substantial, around 0.5, at various points in this period. However, the volatility ratio of REITS to bonds dampened this correlation since the volatility of REIT returns fell while that of bond returns rose in the early 1980s.

By far the most interesting aspect of the bond beta evolution is its steep increase since the early 2000s. The initial rise in bond betas between 2002 and 2009 occurs due to a modest rise in correlations from -0.2 to +0.2, and is greatly amplified by an increase in the volatility ratio of REITS relative to bonds. The recent rise in the bond beta of REITS occurs in a period of normal REIT volatility and is entirely due to a massive increase in the correlation between REIT and bond returns from about -0.2 to +0.4. Interestingly, the correlation between stocks and bonds does not nearly display the same size increase as the correlation between REITS and bond returns. The REIT market currently perceives the interest rate risk of commercial real estate to be especially high. The bond beta of REITS stands at an all-time high of 1.7 at the end of our sample in December 2016. The increased importance of bond risk helps explain the substantial 50% R^2 for the two-factor model in the recent period, as shown in the bottom right hand side panel of Figure 2.

A simple example is informative to understand the magnitude of the bond risk of REITS. Assume
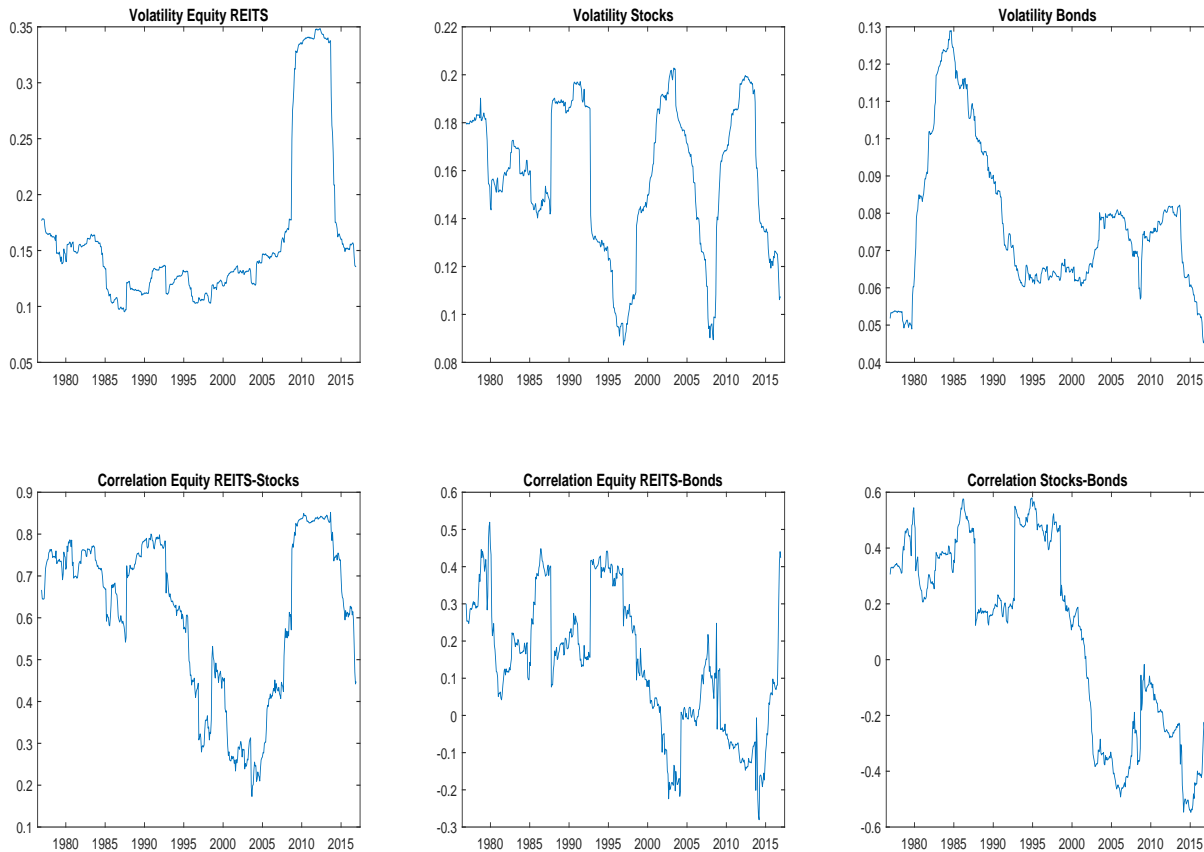
Figure 3: Time-Varying Volatilities and Correlations

The top row plots annualized standard deviations of log excess returns on equity REITS, the stock market, and 10-year Treasury bond returns. Each point reflects the standard deviation of the last 60 months of returns, multiplied by $\sqrt{12}$. The bottom row plots pairwise correlations of monthly log excess returns. The sample period is January 1972 until December 2016.

that the 10-year Treasury has a yield-to-maturity of 2.5%, as it did in December 2016. The modified MacCaulay duration of this 10-year bond is 8.7. A 100 basis point increase in the 10-year Treasury yield (from 2.5 to 3.5%) would (approximately) result in a bond return of -8.7%. With a bond beta of 1.7, this negative bond return would result in a REIT return of -14.8%. The last time we observed a 100 basis points increase in the 10-year yield was between April and August 2013 (from 1.7 to 2.7%), the so-called Taper tantrum. Interestingly, REIT returns over this period were -14.3%, perfectly in line with the model predictions.

The bottom left panel of Figure 2 shows the two-factor alpha estimated over rolling 60-month periods. The alpha is annualized. Average returns and alphas are substantially harder to estimate over short windows than covariances. Therefore, this graph should be interpreted cautiously. The alphas are consistently above zero during the real estate boom period in the early-to-mid 2000s when stock and bond return dynamics explain very little of the REIT returns. Conversely, during the last ten years of the sample, alphas are consistently negative, in a period when stock and bond returns explain 50-70% of REIT return dynamics. While REIT returns were high over the past seven years, they were lower than what they should have been according to the two-factor model.

We can form the time series of the expected returns on REITS, the fair reward for time and risk, as follows:

$$x_t^{2f} = E_t\left[r_{t+1}\right] = r_t^f + \beta_t^s \Lambda^s + \beta_t^b \Lambda^b, \tag{15}$$

Figure 4 shows the three components; the upper envelope is the total expected return, or cost of capital for REITS.

Expected REIT returns were high at about 15% per year in the mid-1970s to mid-1980s period when nominal short rates were very high. They then gradually declined with short rates until the mid-2000s. One exception is the 4% point increase in the 1994-1996 rate hike cycle. In the early 2000s, REIT expected returns were unusually low, not only because short rates were kept low until 2004, but also because equity and bond risk premia were unusually low. As noted before, in this period, REIT returns seemed disconnected from stock and bond dynamics. The high REIT valuation ratios of the mid-2000s are at least directionally consistent with the low expected returns.

Over the past ten years, expected REIT returns have been fairly constant around 8-9%. However, there has been a dramatic change in the composition of that expected return. First, during the zero lower bound period, the time value of money component was absent. Risk premia were historically large at around 8%, fully offsetting the decline in rates. Second, more recently, the balance of risks has shifted towards an increasing contribution from interest rate risk. At the end of the sample, the bond component of the REIT risk premium is 4%, exceeding the equity risk component of 3.9% for the first time in history.
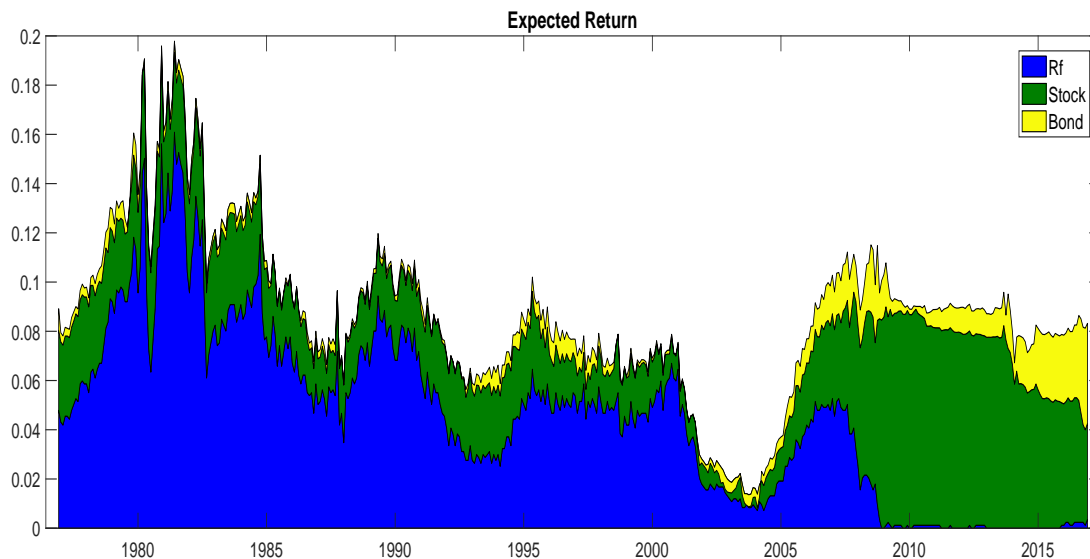
Figure 4: Expected Return of REITS in Two-Factor Model

The figure plots the expected return on equity REITS as implied by the two-factor model in equation (15). The risk factors are the stock market and the 10-year bond excess returns. The betas on the factors are estimated on 60-month rolling windows. To calculate the risk premium, we multiply each beta with the average excess return on the factor over the full 1972–2016 sample.

2.2.2   Five-Factor Model

Unconditional Expected Returns   We now explore richer risk factor models with a view towards better describing REIT expected return dynamics. Column (4) of Table 1 adds three factors to the model of the previous section: a size factor (smb), a value factor (hml), and a momentum factor (mom). All three factors are computed from the universe of U.S. stocks and have received tremendous attention in the empirical asset pricing literature following the seminal work of Fama and French (1992) and Carhart (1997). The size factor goes long small and short large stocks, the value factor goes long high and short low book-to-market stocks, and the momentum factor goes long winners (which had high returns over the recent 12 months) and short losers. It is well-know that REITS behave like small value stocks. Column (4) bears this out. Both the size factor exposure of 0.41 and the value factor exposure of 0.55 are highly significantly different from zero and economically non-trivial. The exposure of REITS to the momentum factor, in contrast, is small and negative and not statistically different form zero. The addition of the three cross-sectional risk factors leaves the equity and bond beta nearly unchanged in the full sample. The five-factor model explains 52.6% of REIT return variation, a large increase

compared to the two-factor model. REITS were fairly valued according to the five-factor model. The unconditional α is a mere -9 basis points per year and indistinguishable from zero (economically and statistically). Our earlier conjecture that some of the two-factor alpha is compensation for un-modeled risk factor exposure is born out in the data.

The fair expected return increases from 8.36% per year in Column (2) to $\overline{x}$ =11.36% in Column (4). The 3% point increase consists of 0.8% compensation for small firm exposure, 2.3% for value exposure, and -0.4% for (negative) momentum exposure. The remaining 0.3% is accounted for by an increase in the estimated stock and bond exposure. Put differently, 40% of the 6.66% overall compensation for risk is accounted for by the three additional risk factors.

Columns (3) of Table 1 drops the momentum factor from the risk factor model. While the results are similar, ignoring the momentum-hedging benefits of REITS tends to overstate the expected return and understate the alpha.

Column (5) studies a different factor model recently proposed by Fama and French (2015). It contains five stock factors, to which we add to it our Treasury excess return factor. The first three equity factors are the same as in columns (3) and (4): the market, smb, and hml. The first new factor is an operating profitability factor (denoted by the label op), which goes long the return on firms with high operating profitability and short firms with low operating profitability. Since this factor has a high correlation with the momentum factor, we report the β^{op} in the same row as the β^{mom}. The second new factor (denoted by the label inv) goes long firms with low investment-to-asset ratios and short firms with high investment ratios. Similar factors were proposed by Hou, Xue, and Zhang (2015).[2] Column (5) shows that REITS have positive and significant exposure to the operating profitability factor. This factor has an excess return of 2.9% per year in the full sample, and contributes 0.5% to the risk premium of REITS. In contrast, REITS have a negative but insignificant exposure to the investment factor, reducing the expected return by 28 basis points. The resulting six-factor model has a marginally better fit than the five-factor model in Column (4). The R^2 is only a quarter of a point higher. The expected return is 0.9% points higher and the alpha falls by the same amount. Because of the small differences, we focus attention on the five-factor model in column (4) in what follows.

---

[2]Hou, Xue, and Zhang (2017) show that the market, size, op, and inv factors go a long way towards accounting for 437 anomalies that have been documented in the empirical asset pricing literature. It is thus a viable candidate risk factor model for our purposes.

Next, we turn to the modern REIT era in Panel B of Table 1. Column (9) contains our favorite five-factor specification. It has a similar R^2 of 52.85% as in the full sample. Most interestingly, the bond beta doubles to 0.48 compared to the full sample estimate in Column (4). It turns statistically significant with a t-statistic of 3.05. The inclusion of size, value, and momentum factors increases both the magnitude and the precision of the bond beta estimate. The same happened in the full sample, but the point estimate in the modern REIT era is twice as large.

The value factor beta also increases relative to the full sample and gains in precision. The momentum exposure of REITS remains negative and small. The cost of capital $\overline{x}$ in the modern REIT era is estimated at 10.70%, substantially above the 8.24% for the two-factor model. Columns (8) and (10) confirm the increased importance of interest rate risk in the modern REIT era. The bond beta is 0.44 and 0.43, respectively and different from zero at the 5% level.

Conditional Expected Returns   Figure 5 shows the time-varying betas for the five-factor model. This is our benchmark model and it is the expected returns form this model that we will use in the calculation of implied growth rates below. The top row confirms that the dynamics of stock and bond betas are changed little by the inclusion of the three additional cross-sectional risk factors. Both stock and bond market risk of commercial real estate rise dramatically at the end of our sample.

The size and value exposures of REITS also decline substantially over the past decade, as shown in the middle panels of Figure 5. The size beta falls from 0.50 in early 2012 to -.05 at the end of the sample in December 2016. Over the same period, the value beta falls from 0.70 to -0.10. Finally, momentum exposure increases from -0.20 to +0.20. Both size and value exposures stand at an all-time low at the end of the sample. The opposite-direction movement of value and momentum betas is consistent with the negative correlation between value and momentum that has been observed by Asness, Moskowitz, and Pedersen (2013) for a wide range of asset classes.

In sum, our results show that there have been important changes in the nature of risk that is priced in the REIT markets. Stock, bond, and momentum risk have become more important while size and value risk have become less important today compared to past periods. These findings are new and have important implications which we discuss below.
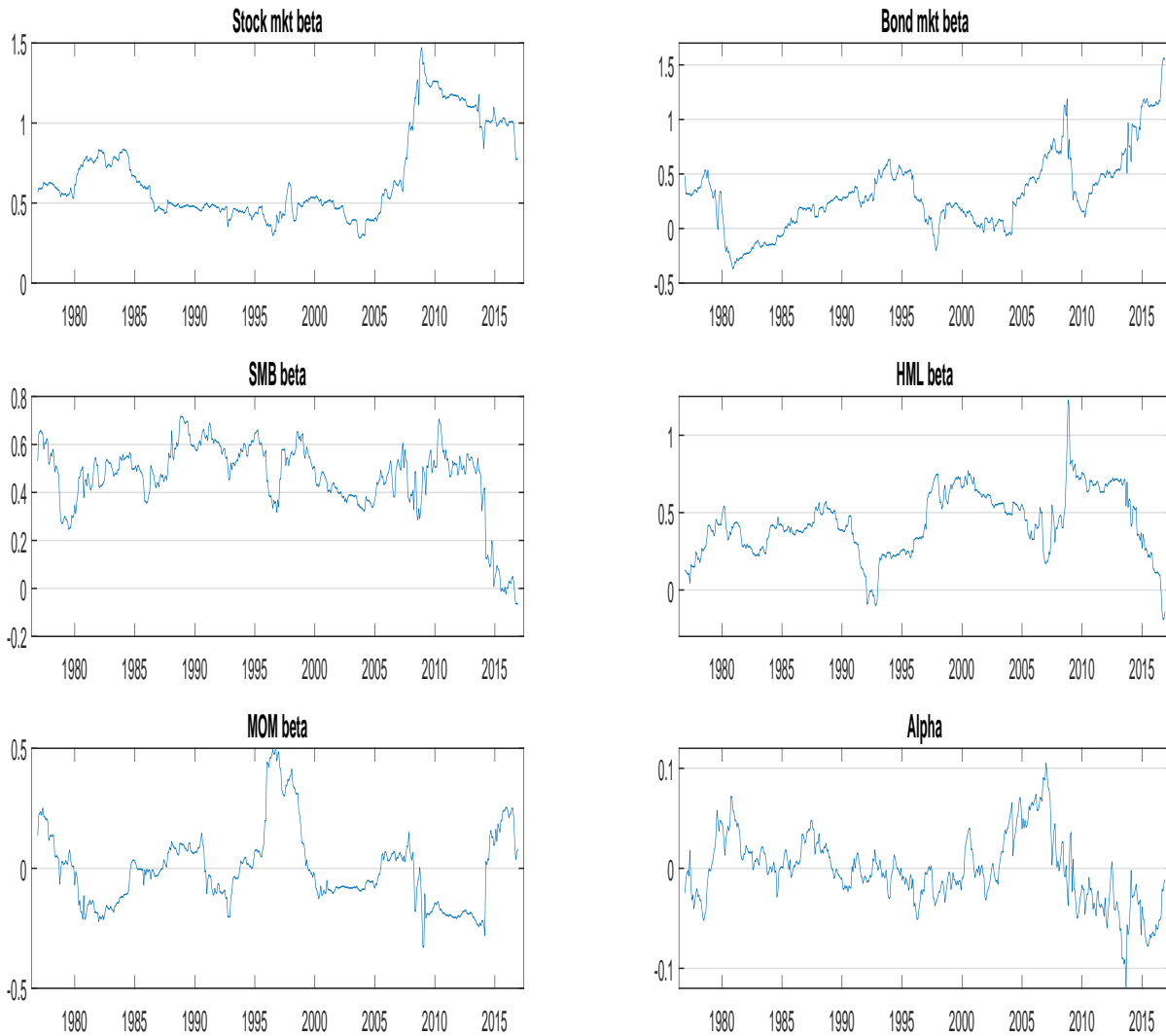
Figure 5: Time-Varying Betas for REITS in Five-Factor Model

The figure plots the exposures (betas) of equity REITS to five risk factors: the stock market, the 10-year bond market return, the size (SMB) factor, the value (HML) factor, and the momentum (MOM) factor. The figure also displays the abnormal return or alpha. In each month, the risk-factor exposures and the alpha are estimated from a multivariate regression using the most recent 60 months of data. The sample period is January 1972–December 2016.

The bottom right panel of Figure 5 shows the annualized five-factor alpha. Like its two-factor counterpart, it has been negative over the past several years. These negative alphas already hint at overvaluation in the listed commercial real estate market which we will explore further below.
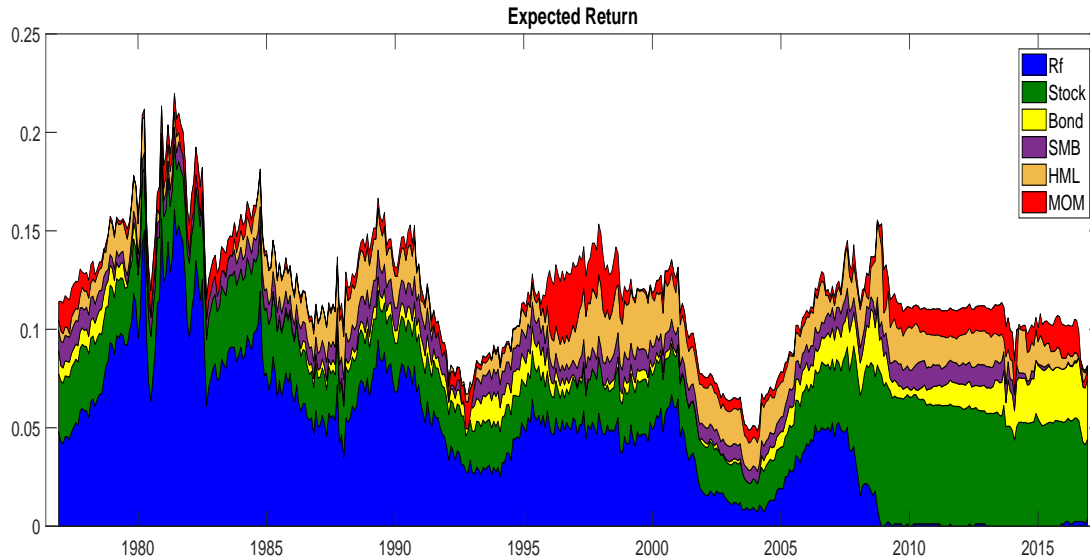
Figure 6: Expected Return of REITS in Five-Factor Model

The figure plots the expected return on REITS as implied by the five-factor model in equation (16). The betas on the factors are estimated on 60-month rolling windows. To calculate the risk premium, we multiply each beta with the average excess return on the factor over the full 1972–2016 sample.

Figure 6 shows the expected return on REITS implied by the five-factor model and its six components: the risk free interest rate captures time value of money while the other components capture the various stock and bond risk premia.

$$x_t^{5f} = E_t\left[r_{t+1}\right] = r_t^f + \beta_t^s \Lambda^s + \beta_t^b \Lambda^b + \beta_t^{smb} \Lambda^{smb} + \beta_t^{hml} \Lambda^{hml} + \beta_t^{mom} \Lambda^{mom}, \tag{16}$$

We use full-sample market prices of risk together with the time-varying betas to construct these risk premia components. The expected return looks qualitatively similar to that from the two-factor model. Our earlier conclusion that the reduction in the time value of money component is fully offset by a rise in risk premia in the last decade is in fact strengthened by the inclusion of the three additional risk factors. The additional risk factors add 2.7% points to the overall risk premium. That is 39% of the total risk premium. However the ratio of the additional risk premium to the overall risk premium fluctuates dramatically. It is as low as -41% (when the additional risk premium is negative), and as high as 72%. As can be seen in the figure, the additional risk premium for size, value, and momentum combined is zero at the end of the sample. A few short years earlier, it was 2.5%.

20

2.3 Beliefs about REIT Dividend Growth

With a time series for expected REIT returns in hand, be it x_t^{2f} defined in equation (15) and plotted in Figure 4 or x_t^{5f} defined in equation (16) and plotted in Figure 6, and a time series for the observed price-dividend ratio, plotted in Figure 1, we now back out the average REIT investor's expectation about future dividend growth using equation (10).

This exercise requires a set of parameters (ρ, ρ_g, ρ_x). We first explain how we choose these parameters. Equation (1) shows that the parameter ρ is pinned down by the long-term mean price-dividend ratio. We obtain $\rho = 0.94$ based on an empirical estimate of $\overline{pd} = 2.80$ (or 16.5 in levels). Since the expected return is an annual number and the expected dividend growth we are interested in uncovering also pertains to an annual quantity, both ρ_x and ρ_g refer to annual persistence parameters. We assume that $\rho_g = 0.60$. It reflects the fact that expected dividend growth on stocks, and especially on REITS, moves at business-cycle frequencies, rather than at generational frequencies (Binsbergen and Koijen, 2010; Koijen and van Nieuwerburgh, 2011). We note that is still substantially above the 12-month autocorrelation of *realized* dividend growth which we estimate to be 0.15. Our assumption is consistent with dividend growth containing a fairly small persistent expected growth component (as in the model of Bansal and Yaron, 2004), and a fairly large (volatile) transitory component. Given the persistence of expected growth, the cumulative effect of a 1%-shock to expected dividend growth ε^g is $1/(1 - \rho\rho_g) = 2.3\% \times \varepsilon^g$.

To gauge the persistence of expected returns, we fit an autoregressive to our monthly time series for x_t^{2f} and x_t^{5f}. The 12-month autocorrelations are estimated to be 0.81 and 0.69. The 12-month autocorrelations of the log price-dividend ratio on REITS is 0.76. For the stock market as a whole we know that expected returns are about as persistent as the price-dividend ratio (Binsbergen and Koijen, 2010; Koijen and van Nieuwerburgh, 2011). Our results confirm that this is also the case for REITS, except that the price-dividend ratio on REITS is less persistent than that for the stock market as a whole. Based on this evidence, we set $\rho_x = 0.81$.

The annual expected dividend growth, g_t, implied by the long-run expected growth rate, the observed demeaned price-dividend ratio, and the expected return per equation (10) is plotted in Figure 7. This is the main figure in the paper. The solid line uses the expected return according to
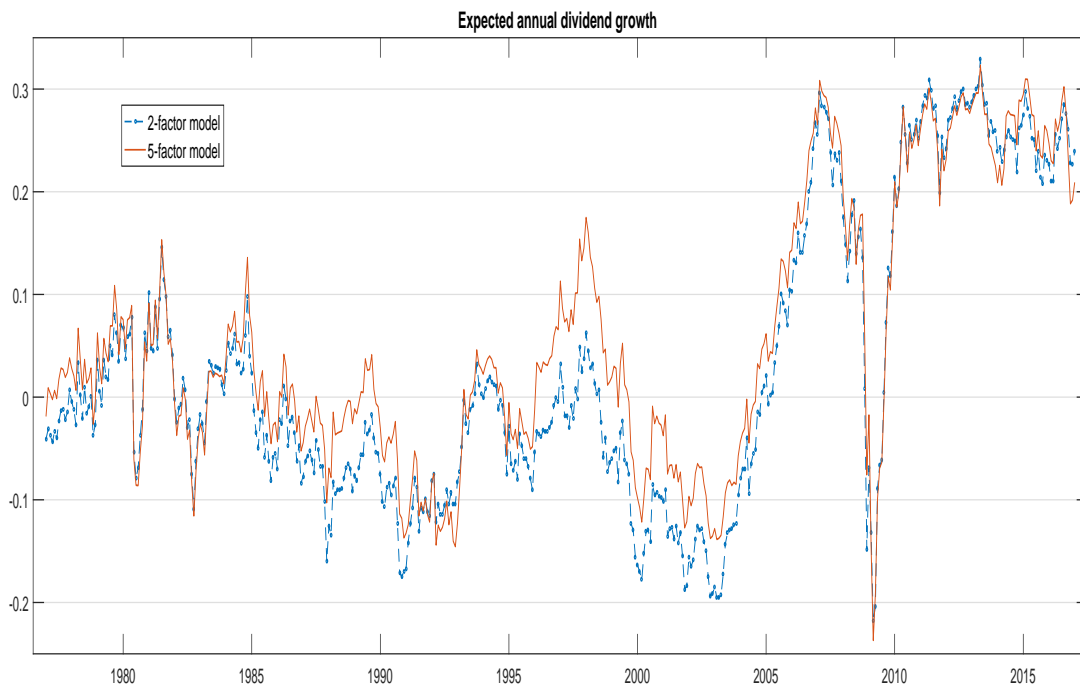
Figure 7: Implied Expected Dividend Growth

The figure plots the expected dividend growth rate g_t, implied by the observed demeaned price-dividend ratio and the expected return per equation (10). The dashed line is for the two-factor model and uses x^{2f} while the solid line is for the five-factor model and uses x^{5f}. The long-run expected growth rate $\overline{g}$ differs across models since the long-run expected return differs and the mean price-dividend ratio is the same.

the five-factor model, while the dotted line is for the two-factor model. The figure shows what the REIT market expects dividend growth to be over the next year. The first observation is that the implications for implied dividend growth are very similar between the two- and five-factor models. The second observation is that implied growth moves around substantially over time. The third and most important observation is that the expected dividend growth rate is much higher after the year 2000 than before. Using the 5-factor model, we obtain a 5.58% unconditional expected growth rate (in nominal terms). The mean is only 0.25% per year before 2000 and 12.8% per year after 2000. What explains the much higher growth expectations in the last part of our sample? We use equation (10) to answer this question.

In late 2003, the REIT price-dividend ratio is close to its long-run average. With expected returns about 7% points below their long-run average of 11.5%, expected dividend growth has to be about 12%

22

below its long-run average of 5.6% to justify the average valuation ratio. In the ensuing boom, REIT valuation ratios rise 55%, peaking in February 2007. Expected returns rise to their long-run average. This implies that annual expected dividend growth must be $(1 - \rho\rho_g) \times 0.55$ or 24% above average at the pre-crisis peak. Taking the persistence of expected growth into account, market participants expected *cumulative* NOI growth to be 55% above trend. This is one metric of "frothy" expectations, given that realized dividend growth over the next two-three years turned out to be highly negative instead.

The massive bust in prices that follows between February 2007 and February 2009 (120 log point decline) results in dividend growth expectations in early 2009 that are 20-30% below average. After the crash, price-dividend ratios recover quickly and are back to 50% above average by early 2010. The remain in the 45-65% above average region for the following six years until the end of our sample. For most of this period expected returns are about 1.5% below their long-run average. However, expected returns are nowhere low enough to justify the high valuation ratios. Consequently, expected dividend growth is highly elevated over this period at about 25% per year. Taking into account the persistence, the market expectation in July 2016 is for cumulative dividend growth over the next several years of 57% above trend. By this metric, the market looks just as "frothy" in July 2016 as it did in February 2007.

In the last five months of 2016, the REIT valuation ratio drops 10%. Over this period, expected returns fall by 2-2.5% points. Implied dividend growth expectations fall from 30.2% per year in July 2016 to 20.9% in December 2016. The cumulative drop in expected dividend growth is 21.5% points. It looks like the REIT market has begun to revise down its lofty expectations about future dividend growth. Nevertheless, they remain at levels that are very high by historical standards.

2.4   Naive Risk Models

Is there a way of reconciling the high valuation ratios in the last six years of the sample? Intuitively, we would need a much lower expected return than the one estimated from the five- or two-factor models. We explore two naive risk models, or mispricing hypotheses, to help understand the current valuation levels. Both are heuristic risk models often used by practitioners. For both of them, we insist on

respecting the long-run valuation equation (4), so that mispricing is ultimately temporary.

Constant Spread Over Ten-Year Treasuries The first naive expected return model sets the expected return on REITS equal to the ten year Treasury bond yield plus a constant spread. This is a common approach in real estate where the ten year yield serves as a benchmark and a constant "cap rate spread" is added. The ten-year constant maturity Treasury yield has averaged 6.23% over the past forty years. We assume long-run expected dividend growth equal to the 5.58% that resulted from the 5-factor model. The long-run valuation equation (4) then implies $\overline{x} = 11.48\%$, the same value as in the 5-factor model. These values generate a "cap spread" spread over the 10-year Treasury of 5.25%. This naive model has the same long-run risk implications as the five factor model, but different dynamics. The left panel of Figure 8 plots the expected return series, zooming in on the last ten years of the sample.

We find that the implied dividend growth rate expectations, plotted in the right panel of Figure 8 (line with diamonds), track those from the five-factor model (solid line) fairly closely. The very low 10-year bond yields over the mid-2010 to mid-2016 period result in 4.2% lower annual expected growth rates. The expected growth rate is still 22.3% per year, which remains implausibly large, and far above the average realized dividend growth rate of 9.3% over the same period. The rise in the 10-year Treasury in the last five months of the sample bring the December 2016 expected return in the naive model within 0.5% of the one in the five-factor model. The implied growth expectations in December 2016 are nearly identical to those in our benchmark model.

Ignoring Rising Interest Rate Risk The second naive model uses a simple version of the two factor model with constant stock and bond betas, set to the full sample estimates of 0.66 and 0.09, respectively. The model implies a constant risk premium of 3.65%. The expected return is the one-month T-bill rate plus this constant risk premium. This simple model entirely ignores the rise in the equity market beta of REITS during the crisis and the more recent rise in interest rate risk. With the economy at the zero lower bound after 2008, the expected return (dashed line with circles eft panel of Figure 8) is flat at 3.65%.[3]

---

[3]The long-run mean expected return in this second naive model is $\overline{x}$ =8.21%. Equation (4) implies that $\overline{g} = 2.31\%$. The low mean expected return must be offset by a low mean dividend growth rate to be consistent with the same
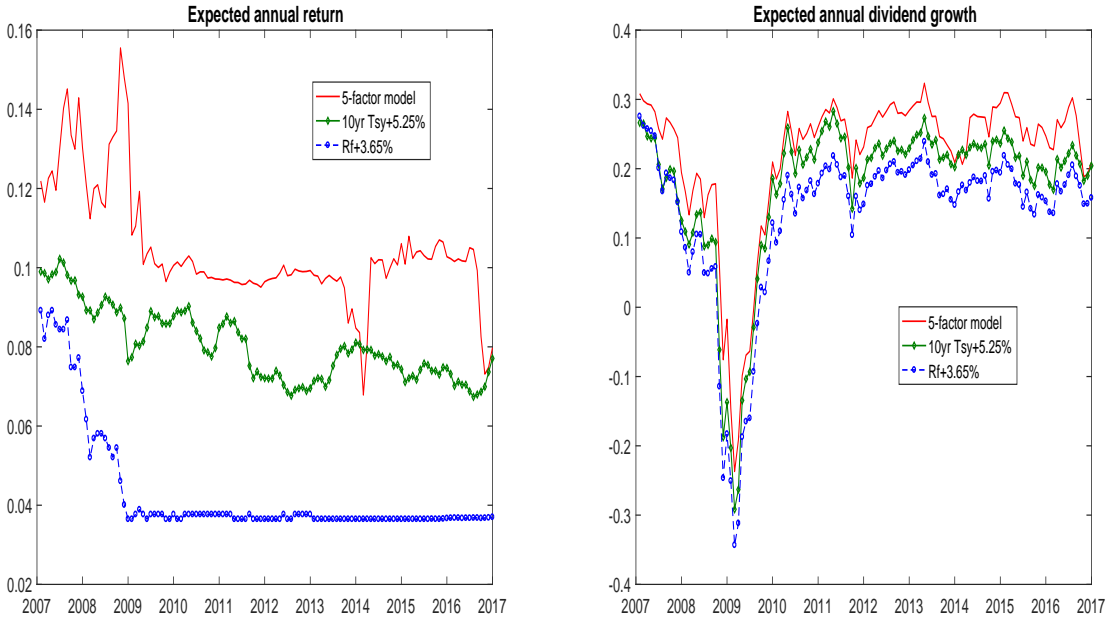
Figure 8: Naive Models For Expected Returns and Implied Dividend Growth Expectations
The figure plots the expected return, x_t, for the five-factor model, the first naive model which sets the expected return equal to the 10-year Treasury plus a constant 5.25% spread, and the second naive model which sets the expected return equal to the 1-month T-bill rate plus a constant spread of 3.65%. The right panel plots the corresponding expected dividend growth rates g_t.

The right panel of Figure 8 shows that the expected dividend growth rate is lower still than in the first naive model. Over the six years between mid-2010 and mid-2016, it is 8.6% per year lower than the five-factor model-implied expected growth. The mean expected growth rate over this six-year period is 18%, which remains elevated. Even the last observation in December 2016 of 13.5% per year is high.

In conclusion, the high observed REIT prices of the post-crisis era are hard to understand, even with a model that assumes a very low discount rate, without elevated expectations about future dividend (NOI) growth. Absent adjustment in the expected return, REIT price-dividend ratios would fall somewhere between 30 and 60% (depending on the risk model) if cash flow growth expectations were to return to their long-run averages. Alternatively, a 5% point increase in the expected return, coupled with a 12% point decrease in the expected growth rate would bring the price-dividend ratio back to its long-run mean, a 50% decline.

long-run mean price-dividend ratio.

25

2.5   Structural Breaks in Long-Run Means

In our main estimation, we calculated the long-run means $\overline{pd}$ and $\overline{x}$ as the full-sample averages. We used equation (4) to solve for the implied long-run growth rate that respects the present-value model. Lettau and Van Nieuwerburgh (2008) find evidence for a structural break in the log price-dividend ratio in the overall U.S. stock market. The long-run mean price-dividend ratio is lower after 1991 than before. They argue for demeaning the price-dividend ratio by its subsample-specific mean. We explore robustness of our results to such a structural break in the long-run price-dividend ratio for REITS. We choose January 1994 as the break point because it is the start of the modern REIT era, the start of our REIT sector data and international data (to be discussed below), and because it is close to the break point found for the overall stock market by Lettau and Van Nieuwerburgh. A change in the long-run mean price-dividend ratio could reflect a permanent change in the long-run growth rate of REIT cash flows, or it could reflect a permanently lower expected return. The latter could be due to a permanent decline in the risk-free interest rate (real rate or inflation) or a structural decline in risk premia, maybe because of improvements in the risk sharing technology (e.g. Lustig and Van Nieuwerburgh, 2005).

In the estimation of expected returns, we use one set or risk prices (Λ) for the estimation windows that end before January 1994 and a different set of risk prices for the windows that end after that date. The risk prices are the average excess returns on the factors for the subsamples 1972-1993 and 1994-2016, respectively. We combine the subsample mean pd ratio with the subsample mean expected return to back out a subsample mean growth rate per equation (4). For the pre-1994 period, we obtain $\overline{pd} = 2.588$, $\overline{x} = 12.93\%$, and $\overline{g} = 5.69\%$. For the post-1994 period, we obtain $\overline{pd} = 2.960$, $\overline{x} = 10.29\%$, and $\overline{g} = 5.23\%$. The higher average valuation ratio in the second subsample is accounted for by the lower long-run average expected return. We then use the subsample-specific demeaned log price-dividend ratio and expected return to back out the implied dividend growth rate according to equation (10). The resulting expected dividend growth is very similar to the one we estimate when all averages are computed over the full sample. Over the last seven years of the sample, expected growth is 3.5% lower per year with structural break adjustment than without, but remains very high at 22.8% per year. Therefore, our conclusions are unaltered.[4]

---

[4]Detailed results are available from the author upon request.

2.6 Missing Hedging Properties of REITS?

The main asset pricing model considered above is the fairly rich five-factor model that has been successful at explaining many empirical asset pricing phenomena. Nevertheless, the model for the REIT expected returns may be misspecified. We evaluate robustness of the results to two inter-related misspecification concerns. A first possibility is that REITS may be good hedges for macro-economic left-tail risk. REIT returns may be high exactly when the likelihood of a macro-economic or financial disaster increases. If true, REITS offer a hedge against such tail risk, and should have lower expected excess returns and higher prices, all else equal. A second, related, possibility is that REIT pricing is affected by systemic risk in financial intermediation. REITS may offer high returns exactly when intermediaries are poorly capitalized. This could be because the relative scarcity of high quality collateral like real estate increases in such states of the world.[5]

Appendix A uses data on the probability of a macro-economic disaster from Siriwardane (2015) and Giglio, Kelly, and Pruitt (2016), and data on the intermediary equity capital ratio from He, Kelly, and Manela (2017) to explore the conjectured hedging benefits of REITS. It finds that REITS are exposed to increases in left-tail risk and to deteriorations in intermediary equity capital ratios, rather than being a hedge for these risks. This is the case both in univariate correlations, as well as in multi-variate analysis once exposure to stocks and bonds (through the two- of five-factor model) is accounted for. The poor performance of REITS during the financial crisis is a good example of this macro-economic and financial disaster risk exposure. Augmenting the five-factor model with any of these three "fragility factors" results in a higher expected return. This is the case both unconditionally and for the last six years of the sample, when estimating time-varying betas. This result deepens the puzzle of the high prices, or low expected returns, on REITS. Put differently, incorporating the exposure of REITS to macro-economic or financial disasters would result in even higher implied dividend growth rates than the ones presented above.

---

[5]I am grateful to the Editor for encouraging me to explore these possibilities.

3   Cross-Sectional Evidence

In this section, we explore valuations in the various REIT sectors. We use the following sectors: Apartments (A), Office (O), Industrial (I), Retail (R), Lodging (L), HealthCare (H), Diversified (D), and Self-storage (S). The return data are form NAREIT and available for the modern REIT sample from January 1994 until December 2016.

3.1   Unconditional Expected Return

Table 2 presents the results for unconditional expected returns under the five-factor model. Several interesting facts emerge about cross-sectional differences in risk exposure. First, there are on-trivial sectoral differences in expected returns, as reported in the last row of the table. Expected returns range from 9.46% for Health care REITS, the least risky sector, to 15.1% for Industrial REITS, the most risky sector. The risk-free rate averages 2.45% over this sample; risk premia range from 7% to 12.6% per year across industries.

Second, the stock market beta ranges from around 0.5 for Self-storage (S) and Health care (H) to twice that level for Lodging (L) and Industrial (I). We interpret the stock market beta as exposure to the economic cycle. Industrials and hotels are well-known to be highly cyclical real estate sectors. Self-storage and Health care fulfill more basic needs and are less sensitive to economic activity. Apartments (0.67), Retail (0.74), and Office (0.84) are in between.

Third, the bond betas also vary in substantial and intuitive ways. Lodging has the lowest bond beta (0.11), followed by Apartments (0.31), and Office (0.39). At the other end of the spectrum, we find Retail (0.62), Self-storage (0.66), Healthcare (0.69), and Industrial (0.82). The ratio of the highest to the lowest interest rate risk exposure is more than 7. The bond beta is different from zero for all sectors except Lodging. This bond beta ranking is intuitive under a *lease duration* perspective. Hotels can change their lease rates on a daily basis. Apartments typically employ 12-month lease contracts. On the other end of the spectrum, Industrials use triple net lease contracts of long duration, sometimes 20-years or more. Many Industrial and Health care facilities are built-to-suit for a single tenant, helping to explain these long lease durations. When interest rates change, maybe because inflation

Table 2: **REIT Sector Expected Returns**

The dependent variables are the excess return on the equity REIT sector indices. The independent variables are listed in the main text. The first row reports the intercept α, multiplied by 1200, the other rows report risk factor exposures β. The t-statistics are computed using Newey-West standard errors with one lag. The last but one row reports the R^2 of the regression. The last row reports the expected return according to the regression model. It includes the risk-free rate and excludes the alpha. It is multiplied by 1200. The data are monthly from January 1994–December 2016.

	(A)	(O)	(I)	(R)	(L)	(H)	(D)	(S)
α	1.54	−0.58	−5.85	−0.31	−7.08	1.94	−2.33	5.50
t-stat	0.46	−0.16	−0.85	−0.07	−1.70	0.53	−0.68	1.56
β^s	0.67	0.84	1.16	0.74	1.09	0.56	0.76	0.54
t-stat	7.35	7.81	4.47	5.28	10.95	6.21	8.59	6.29
β^b	0.31	0.39	0.82	0.62	0.11	0.69	0.44	0.66
t-stat	2.11	2.24	2.40	2.89	0.68	3.27	2.90	3.65
β^{smb}	0.37	0.45	0.52	0.50	0.79	0.31	0.53	0.42
t-stat	4.63	4.90	3.21	5.01	7.40	3.16	6.57	4.67
β^{hml}	0.69	0.75	0.95	0.71	1.04	0.59	0.73	0.51
t-stat	6.24	6.74	4.14	4.89	9.22	4.22	6.14	4.07
β^{mom}	−0.04	−0.07	−0.07	−0.17	−0.36	−0.14	−0.14	−0.02
t-stat	−0.56	−0.89	−0.81	−1.76	−3.28	−2.59	−1.68	−0.32
R^2	42.56	51.72	41.63	44.45	64.26	31.96	52.87	29.70
Exp. ret.	9.79	11.23	15.11	10.90	12.35	9.46	10.71	9.64

rates change, lease rates on hotels and apartments can adjust fairly quickly. Lodging and Apartments behave like floating-rate bonds in that their cash flows are tied to the short-term interest rate. They have no or low interest rate risk, or duration, since the cash-flow effect of changing rates offsets the discount rate effect. A lease on an industrial property cannot adjust for a long-time; the cash-flows on industrial REITS behave more like long-term fixed-rate bonds. Industrials have high interest rate risk, or duration, just like long-term bonds.[6]

The differential interest rate risk exposures imply large differences in the response to an interest rate shock. Recalling the earlier example, a 100 basis point increase in the 10-year Treasury yield (from 2.5 to 3.5%) would result in a 10-year Treasury bond return of -8.7%. In response to this shock, Lodging REITS would fall by less than 1% while Industrial REIT prices would fall by more than 7%.

Fourth, there are some differences in the size and value exposures worth noting. Apartments and Self-storage have low exposure to size and value, helping to explain their overall low expected return. Industrials and especially Lodging have high size and value betas, contributing meaningfully to their high risk and expected return. The differences in momentum exposure are generally smaller and insignificant, other than for Lodging (-0.36) and Health care (-0.14).

Finally, there are large economic differences between alphas across sectors, though the sample is too short and abnormal returns too volatile to produce any statistical significance. Self-storage has historically returned 5.5% more return than warranted by the 5-factor model. Health care (1.9%) and Apartments (1.5%) have also outperformed. On the other end of the spectrum are Industrials which have generated average returns that were 5.85% per year too low, relative to its risk profile. Lodging fared even worse and under-performed by 7% per year.

3.2   Implied Dividend Growth

As we did for the REIT market as a whole, we back out what sectoral REIT price-dividend ratios combined with expected returns imply for expected dividend growth. We use the five-factor model as our expected return model and estimate time-varying betas separately for each sector. We fix the

---

[6]Along similar lines, Stanton and Wallace (2008) price leases across property types in a contingent claims valuation model.

parameters (ρ, ρ_x, ρ_g) to the values we used for the overall REIT market. Each sector has its own long-un mean price-dividend ratio $\overline{pd}$ and long-run mean expected return $\overline{x}$, which together imply a sectoral long-run mean expected growth rate $\overline{g}$.

The left panel of Figure 9 shows the implied annual dividend growth over the full sample for the four major property types. Expected growth dynamics are broadly similar across sectors over the full time-series, but with some interesting cross-sectional variation. Industrial generally has the highest implied growth rates, or put differently the highest valuations after taking into account risk. Apartments has often had the lowest implied growth rates, at least until recently.
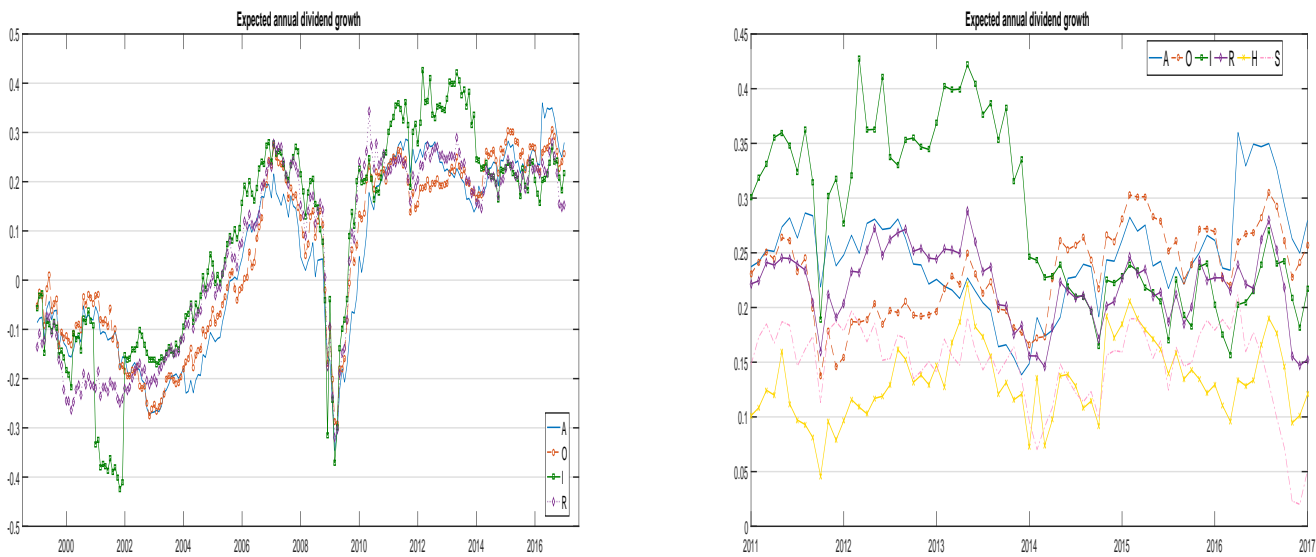

Figure 9: Sectoral Implied Dividend Growth Expectations
The figure plots the implied expected dividend growth rates g_t, corresponding to the observed log price-dividend ratio and the five-factor expected returns for each sector. The left panel is for the January 1994 until December 2016 sample. The graph starts in January 1999 allowing for the first 60-month window after January 1994 to estimate betas. The right panel zooms in on the period from January 2011 until December 2016. The sectors are Apartments (A), Office (O), Industrial (I), Retail (R), Health care (H), and Self-storage (S).

The right panel of Figure 9 zooms in on the last 72 months of the sample. It adds in the Health care (H) and Self-storage (S) sectors. In 2013, annual expected growth rates vary between 40% for Industrial (I) and 10% for Health care (H). As the financial crisis disappears in the rear view mirror in 2014, the expected returns on Industrials fall due to its high equity beta. The lower expected return makes it easier to justify the high valuation ratios, and the implied dividend growth rate falls below

20%.

At the end of 2016, there is divergence in implied growth rates. Among the major property types, apartments now look the most expensive with an implied growth rate north of 25% while retail looks the cheapest with an implied growth rate of 15%. The two non-traditional REIT sectors, Health care and Self-storage are the cheapest with implied growth rates of 12% and 5%, respectively.

4 International Evidence

A final question we study is whether our results are specific to the United States, or rather reveal common growth expectations dynamics around the world.

We use the MSCI/IPD World Core Real Estate index. The index focuses on mid- and large-cap real estate stocks from 23 countries.[7] The return series, expressed in U.S. dollars, is available to us at monthly frequency from December 1994 until June 2015. We use the global market portfolio from Fama and French (2012) as our global stock market benchmark. From the same source, we also obtain data on global size, value, and momentum factors.[8] We use the Barclays Global Aggregate Bond Index as our global bond benchmark. This index contains both government and corporate bonds. We continue to use the U.S. one-month T-bill rate for R^f, as the pre-eminent safe asset return in the world.

---

[7]As noted by MSCI (2014): "The MSCI Core Real Estate Index, based on the MSCI ACWI Investable Market Indexes (the 'Parent Index'), are designed to reflect the performance of stocks in the Parent Index engaged in the ownership, development and management of specific core property type real estate. Specifically, these indexes exclude companies that do not own properties. For example, companies active in real estate services and real estate financing are not included in the MSCI Core Real Estate Indexes." REITS that are not involved in core real estate property (such as timber or infrastructure REITS) are not included; neither are mortgage REITS. As of May 2015, the CREI index included 390 companies in many different subsectors and geographies. The sub-sectors are Real Estate Development, Real Estate Operating Companies, Residential REITS, Retail REITS, Office REITS, Industrial REITS, Diversified REITS, Specialized REITS such as self-storage REITS, and Diversified Real Estate Activities. In terms of country composition in May 2015, the United States represented 49.9%, Japan 13.9%, Hong Kong 9.7%, the U.K. 6%, and Australia 5.5%. Europe ex-U.K. represented 9.3% of the basket.

[8]The global factor include 23 countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Switzerland, Sweden, United Kingdom, United States. The global market factor has a correlation of 99.3% with the MSCI All Country World Index equity index (ACWI). We consider the Fama-French index a better proxy of the world equity market portfolio than the ACWI, which is skewed towards larger stocks.

4.1 Unconditional Expected Return

Table 3 presents the unconditional expected return analysis. The first two columns are for the international data; the first column is the global two-factor model while the second column is the global 5-factor model. For comparison, the last two columns present the U.S. results, estimated over the same period but with U.S. risk factors. We note that the global factor models fit the data substantially better than the U.S. model. The global 5-factor model generates a R^2 of 71.4%. Second, the stock market beta is higher than in the U.S. model at 0.88. Third, the bond beta is higher as well at 0.56. This could partly be due to the use of the Barclays bond index rather than a long-term government bond index. Fourth, size, value, and momentum exposure are smaller in absolute value in the global than in the U.S. model. Combining the risk premia on the global factors with the estimated factor exposures, we arrive at the expected return on the global REIT portfolio. It is 8.56% per year for the 2-factor model and 10.2% per year according to the 5-factor model. These expected returns are 0.5% to 1.5% lower than the U.S. counterparts. Average realized returns on global real estate stocks were 0.4% and 2.1% lower than their unconditional expected returns, respectively, but neither negative alpha is statistically different from zero. We conclude that global REITS are fairly valued based over the full sample, based on the 2- and 5-factor models.

4.2 Implied Dividend Growth

As we did for the U.S. REIT market, we back out what the time series for the global REIT price-dividend ratio combined with the time series for the global 5-factor expected return model with time-varying betas imply for the market's expectation about annual dividend growth. We fix the parameters (ρ, ρ_x, ρ_g) to the values we used for the U.S. REIT market. In the interest of space, we do not report on the time-varying betas but simply note that the patterns described for the U.S. also hold internationally. Specifically, the equity beta of global REITS increases in the period spanning the global financial crisis and falls in the last few years of the sample. Interest rate risk of global REITS increases substantially. The bond beta with respect to the Barclays global bond index rises from 0 to 1 over the last five years of the sample. Size and value betas decline towards the end of the sample, insofar that the 5- and 2-factor models imply nearly the same cost of capital in the last month of the

Table 3: **International REIT Expected Returns**

The dependent variables are the excess return on the MSCI World Core Real Estate index in columns (1) and (2) and the excess return on the NAREIT All Equity REIT index in the U.S. in columns (3) and (4). The independent variables are listed in the main text. In columns (1) and (2), we use global stock and bond factors, while in columns (3) and (4) we use U.S. factors. The bond factor is the excess return on the Barclays Global Aggregate Bond Index in the first two columns and the excess return on the U.S. 10-year Treasury bond in the last two columns. The first row reports the intercept α, multiplied by 1200, the other rows report risk factor exposures β. The t-statistics are computed using Newey-West standard errors with one lag. The last but one row reports the R^2 of the regression. The last row reports the expected return according to the regression model. It includes the risk-free rate and excludes the alpha. It is multiplied by 1200. The data are monthly from December 1994–June 2015.

	Intl 2f	Intl 5f	US 2f	US 5f
α	−0.40	−2.08	1.62	−1.11
t-stat	−0.15	−0.84	0.37	−0.32
β^s	0.84	0.88	0.78	0.76
t-stat	10.20	12.77	5.47	7.28
β^b	0.68	0.56	0.31	0.49
t-stat	4.84	4.49	1.36	3.10
β^{smb}	–	0.33	–	0.53
t-stat	–	4.22	–	7.10
β^{hml}	–	0.60	–	0.80
t-stat	–	6.80	–	7.85
β^{mom}	–	−0.06	–	−0.12
t-stat	–	−1.29	–	−2.08
R^2	62.83	71.36	33.50	58.20
Exp. ret.	8.56	10.24	9.04	11.77

international data, June 2015: 6.56% vs. 6.45%, respectively.

Combined with $\overline{x} = 8.53\%$, the mean valuation ratio of $\overline{pd} = 3.20$ results in a long-run dividend growth expectation for global REITS of $\overline{g} = 4.54\%$ by equation (4). The corresponding numbers for the U.S., measured over the same sample, are $\overline{x} = 10.56\%$, $\overline{pd} = 3.01$, and $\overline{g} = 5.76\%$.

Figure 10 plots the time series of the implied growth rate for global REITS (solid line) and U.S. REITS (dashed line with circles). In the early years of the sample, global REIT investors priced in higher growth than U.S. investors. Global REIT prices were about average and so were expected returns. In contrast, U.S. REIT prices were far below average while expected returns were slightly above average, requiring pessimistic growth expectations. The two implied dividend growth series track each other fairly closely from 2005 to 2009. The main difference between the two series occurs after 2010. While REIT valuation ratios are similarly high globally and in the U.S., the risk in global REITS is meaningfully smaller so that much lower implied growth rates are needed to justify the valuations. By the end of the sample period in mid-2015, implied dividend growth in global REITS is elevated at around 7-10% per year. However, that pales in comparison to the 20% annual growth rate assumption necessary to justify valuations in the U.S. It would seem that U.S. REIT markets are at a greater risk of an expectation-induced price correction.

5   Implications for Non-Listed Real Estate

While our study focusses on public real estate markets, this section argues that its insights apply more broadly to private real estate markets and the risk-return relationship of real estate assets.

A first suggestive piece of evidence is that valuation ratios behave similarly for public and private real estate. Figure 11 plots the ratio of the price to net operating income (NOI) for the NCREIF Property Price Index. It compares this index to the price-NOI ratio for REITS. The resulting series have similar average valuation ratios and broadly similar dynamics. Like that of REITS, the NCREIF valuation ratio displays a boom-bust-boom pattern, and NCREIF price-NOI ratios are at the same levels than those of REITS at the end of the sample.

Second, models for expected returns for private real estate have arrived at similar conclusions
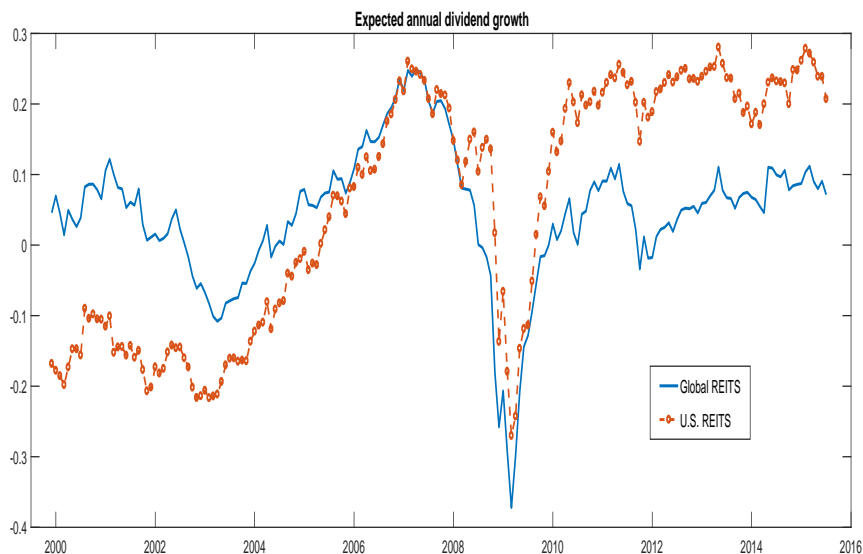
Figure 10: Global REIT Implied Dividend Growth Expectations
The figure plots the implied expected dividend growth rates g_t, corresponding to the observed log price-dividend ratio and the five-factor expected returns for global listed real estate (solid line) and U.S. REITS (dashed line). The estimation sample is December 1994 until June 2015 sample. The graph starts in November 1999 since 60 months of data are needed to estimate the first set of factor exposures.

regarding the sources of systematic risk in private real estate. Ang, Chen, Goetzmann, and Phalippou (2014) use cash flows from real estate private equity (REPE) funds to estimate the exposure of such funds to systematic risk factors such as the three Fama-French factors and the illiquidity risk factor of Pastor and Stambaugh (2003). They find equity betas of 0.7 for REPE funds, similar to those we estimated for REITS, as well as similar exposure to size and value factors. They also find that REPE funds are exposed to illiquidity risk in the stock market. After accounting for these risk factor exposures, the average abnormal return or alpha for REPE funds is indistinguishable from zero, as we found for REITS. Finally, they show that returns on REPE funds are as volatile as those of REITS (around 20% annual standard deviation), in contrast to the much lower volatility of NCREIF returns (4.2% annual standard deviation).

Indeed, it is by now well understood that many direct commercial property price indices suffer from artificially low volatility and correlation with REITS and other listed asset returns. Direct real estate transacts infrequently and indices, like the NCREIF, are based on periodic appraisals. Appraisal-based indices tend to exhibit significant smoothing, serial correlation, and lags relative to REIT returns (see,
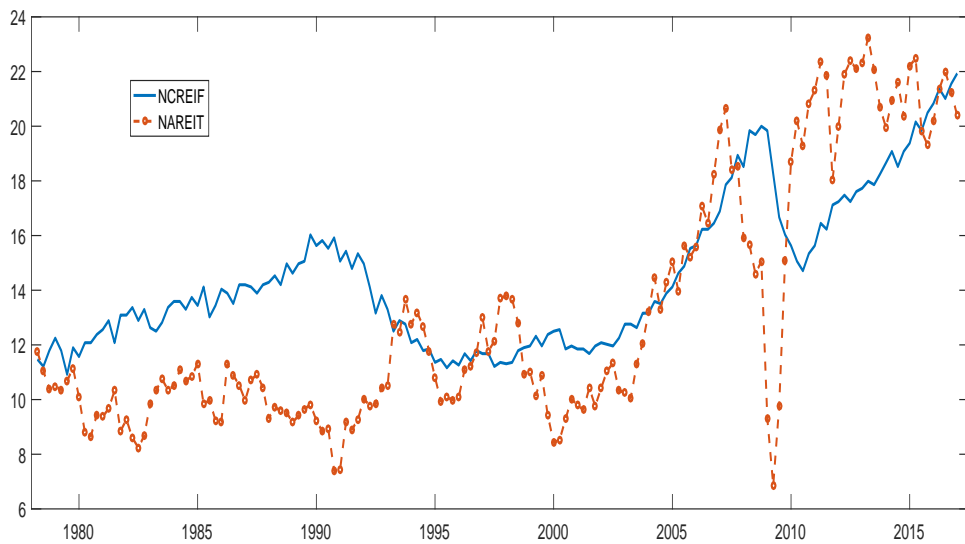
Figure 11: Price to NOI Ratio in Private and Public Markets

This figure plots the ratio of the price to net operating income (NOI) for the NCREIF Property Price Index (solid line) and the price-NOI ratio for the NAREIT All equity REIT Index. REIT dividends and the NOI of the underlying real estate assets are not the same due to leverage and the fact that REITS can retain depreciation. However, the two cash-flow measures are closely linked by the requirement of REITS to pay out most of their earnings. Historically, REITS have paid out about 75% of funds from operations as dividends. Scaling the NAREIT price-dividend ratio by 0.75 generates a comparable series of price-NOI for REITS. The sample period is quarterly from 1978.Q1–2016.Q4.

for example, Geltner, 1991, 1993; Ross and Zisler, 1991). The lagged drop in NCREIF real estate prices can be seen clearly in Figure 11. Work that undoes the smoothing, as well as corrects for leverage and the differences between property types in the respective indices concludes that real property returns are significantly more volatile than the original appraisal-based indices suggested (Pedersen, He, Tiwari, and Hoffmann, 2012; Shepard, Liu, and Dai, 2014). Corrected private real estate returns are also significantly more correlated with listed real estate. Correlations increase sharply with the return horizon (see, for example, Giliberto, 1990; Geltner and Kluger, 1998). But even at quarterly frequency, estimates of the correlation between public and private real estate returns increase to around 80% for many countries, including the U.S. and U.K., after controlling for smoothing and leverage (Shepard, Liu, and Dai, 2014). The majority of this literature concludes that expected returns on listed real estate exceed those on unlisted real estate (Riddiough, Moriarty, and Yeatman, 2005; Pagliari, Scherer, and Monopoli, 2005; Tsai, 2007; Ling and Naranjo, 2015). The analysis of Ang, Chen, Goetzmann, and Phalippou (2014) suggest these results on the representativeness of REIT returns for the broader real estate asset class extend from raw to risk-adjusted returns. In sum, there is now strong evidence that public and private real estate investments can be regarded as close substitutes (Kutlu, 2010; Bond and Chang, 2013; Boudry, Coulson, Kallberg, and Liu, 2012; Hoesli and Oikarinen, 2012; Stefek and Suryanarayanan, 2012; Yunus, Hansz, and Kennedy, 2012; Ang, Nabar, and Wald, 2013). Our risk analysis and insights for what valuation ratios imply for future NOI growth carry over to commercial real estate investments more broadly.

6   Conclusion

Valuation ratios on listed U.S. real estate assets have been at all-time highs for several years now. We argue that historically low interest rates or lower expected returns more broadly cannot account for the high prices. Rather the high prices reflect optimistic expectations about future income growth from commercial properties. Those expectations far exceed historical average income growth rates. By the logic of the present-value model, a downward revision in the cash-flow growth expectations would lead to a decline in real estate prices. We view a sharp reduction in expected returns as an unlikely alternative correction mechanism. Indeed, our analysis shows that real estate has become more vulnerable than ever to an increase in interest rates and/or an economic contraction.

References

Anderson, Randy, Jim Clayton, Greg Mackinnon, and Rajneesh Sharma, 2005, Reit returns and pricing: The small cap value stock factor, *Journal of Property Research* 22, 267–286. 2

Ang, Andrew, Bingxu Chen, William N. Goetzmann, and Ludovic Phalippou, 2014, Estimating private equity returns from limited partner cash flows, Working paper Columbia University. 36, 38

Ang, Andrew, Neil Nabar, and Samuel J. Wald, 2013, Searching for a common factor in public and private real estate returns, *Journal of Portfolio Management* 39, 120–133. 38

Asness, Clifford S., Tobias J. Moskowitz, and Lasse Heje Pedersen, 2013, Value and momentum everywhere, *The Journal of Finance* 68, 929–985. 18

Bansal, Ravi, and Amir Yaron, 2004, Risks for the long run: A potential resolution of asset pricing puzzles, *Journal of Finance* 59, 1481–1509. 21

Binsbergen, Jules van, and Ralph Koijen, 2010, Predictive regressions: A present-value approach, *Journal of Finance* 65 (4). 7, 21

Bond, Shaun A., and Qingqing Chang, 2013, REITs and the private real estate market, in H. Kent Baker, and Greg Filbeck, ed.: *Alternative Investments: Instruments, Performance, Benchmarks, and Strategies* . chap. 5, pp. 79–97 (John Wiley). 38

Boudry, Walter I., N. Edward Coulson, Jarl G. Kallberg, and Crocker H. Liu, 2012, On the hybrid nature of REITs, *Journal of Real Estate Finance and Economics* 44, 230–249. 38

Brunnermeier, Markus, and Yuliy Sannikov, 2012, A macroeconomic model with a financial sector, *American Economic Review,* forthcoming. 44

Campbell, John Y., and Robert J. Shiller, 1989, The dividend-price ratio and expectations of future dividends and discount factors, *Review of Financial Studies* 1, 195–228. 1, 5

Campbell, Sean D., Morris A. Davis, Joshua Gallin, and Robert F. Martin, 2009, What moves housing markets: A variance decomposition of the rent-price ratio, *Journal of Urban Economics* 66. 6

Carhart, Mark M., 1997, On persistence in mutual fund performance, *Journal of Finance* 52, 57–82. 2, 16

Davis, Morris, and Stijn Van Nieuwerburgh, 2014, Housing, finance and the macroeconomy, in Gilles Duranton, and William Strange, ed.: *Handbook of Regional Economics* (Elsevier Science B.V.: North Holland). 2

Fama, Eugene F., and Kenneth R. French, 1992, The cross-section of expected stock returns, *Journal of Finance* 47, 427–465. 2, 16

———— , 2012, Size, value, and momentum in international stock returns, *Journal of Financial Economics* 105, 457–472. 32

———— , 2015, A five-factor asset pricing model, *Journal of Financial Economics* 116, 1–22. 17

Favilukis, Jack, Sydney C. Ludvigson, and Stijn Van Nieuwerburgh, 2017, The macroeconomic effects of housing wealth, housing finance and limited risk sharing in general equilibrium, *Journal of Political Economy* 125, 140–222. 2

Geltner, David, 1991, Smoothing in appraisal-based returns, *Journal of Real Estate Finance and Economics* 4, 327–345. 38

——— , 1993, Estimating market values from appraisal values without assuming an efficient market, *Journal of Real Estate Research* 8, 352–345. 38

Geltner, D., and B. Kluger, 1998, REIT-based pure-play portfolios: The case of property types, *Real Estate Economics* 26, 581–612. 38

Giglio, Stefano, Bryan Kelly, and Scott Pruitt, 2016, Systemic risk and the macroeconomy: An empirical evaluation, *Journal of Financial Economics.* 27, 44, 48, 51

Giliberto, S.M., 1990, Equity real estate investment trusts and real estate returns, *Journal of Real Estate Research* 5, 259–263. 38

He, Zighuo, Bryan Kelly, and Asaf Manela, 2017, Intermediary asset pricing: New evidence from many asset classes, *Journal of Financial Economics* forthcoming. 27, 44, 45

He, Zhiguo, and Arvind Krishnamurthy, 2013, Intermediary asset pricing, *American Economic Review* 103 (2), 732–770. 44

——— , 2014, A macroeconomic framework for quantifying systematic risk, Working Paper University of Chicago and Stanford University. 44

Hoesli, Martin, and Elias Oikarinen, 2012, Are REITs real estate? Evidence from international sector level data, *Journal of International Money and Finance* 31, 1823–1850. 38

Hou, Kewei, Chen Xue, and Lu Zhang, 2015, Digesting anomalies: An investment approach, *Review of Financial Studies* 28, 650–705. 17

——— , 2017, A comparison of new factor models, Working Paper Ohio State University. 17

Karolyi, G. A., and A. Sanders, 1998, The variation of economic risk premiums in real estate returns, *Real Estate Finance and Economics* 17, 245–262. 2

Koijen, Ralph, and Stijn van Nieuwerburgh, 2011, Predictability of stock returns and cash flows, *Annual Review of Financial Economics* 3, 467–491. 7, 21

Kutlu, Vesile, 2010, The long term relation between indirect and direct real estate, Msc thesis Tilburg University. 38

Lettau, Martin, and Stijn Van Nieuwerburgh, 2008, Reconciling the return predictability evidence: In-sample forecasts, out-of-sample forecasts, and parameter instability, *Review of Financial Studies* 21, 1607–1652. 3, 7, 26

Ling, D.C., and A. Naranjo, 2015, Returns and information transmission dynamics in public and private real estate markets, *Real Estate Economics* 43, 163–208. 38

Lustig, Hanno, and Stijn Van Nieuwerburgh, 2005, Housing collateral, consumption insurance and risk premia: an empirical perspective, *Journal of Finance* 60, 1167–1219. 26

Mian, Atif, and Amir Sufi, 2011, House prices, home equity-based borrowing, and the u.s. household leverage crisis, *American Economic Review* 101, 2132–2156. 2

MSCI, 2014, MSCI core real estate indexes methodology, index construction and maintenance methodology for the MSCI core real estate indexes, . 32

Pagliari, Jr., Joseph L., Kevin A. Scherer, and Richard T. Monopoli, 2005, Public versus private real estate equities: A more refined, long-term comparison, *Real Estate Economics* 33, 147–187. 38

Pastor, Lubos, and Robert F. Stambaugh, 2003, Liquidity risk and expected stock returns, *Journal of Political Economy* 111. 36

Pedersen, Niels, Fei He, Ashish Tiwari, and Andrwe Hoffmann, 2012, Modeling the risk characteristics of real estate investments, Technical report PIMCO. 38

Peterson, J., and C. Hsieh, 1997, Do common risk factors in the returns on stocks and bonds explain returns on reits?, *Real Estate Economics* 25, 321–345. 2

Riddiough, Timothy J., Mark Moriarty, and P.J. Yeatman, 2005, Privately versus publicly held asset investment performance, *Real Estate Economics* 33, 121–146. 38

Ross, Stephen A., and Randall C. Zisler, 1991, Risk and return in real estate, *Journal of Real Estate Finance and Economics* 4, 175–190. 38

Shepard, Peter, Yang Liu, and Yilin Dai, 2014, The Barra private real estate model (PRE2), Research notes MSCI. 38

Siriwardane, Emil, 2015, The probability of rare disasters: Estimation and implications, Working Paper Harvard Business School. 27, 44, 47, 48, 49

Stanton, Richard, and Nancy Wallace, 2008, An empirical test of a contingent claims lease valuation model, *Real Estate Research* 31, 1–26. 30

Stefek, Dan, and Raghu Suryanarayanan, 2012, Private and public real estate: What is the link?, *Journal of Alternative Investments* 14, 66–75. 38

Tsai, Jengbin Patrick, 2007, A successive effort on performance comparison between public and private real estate equity investment, Master's thesis MIT Center for Real Estate. 38

Yunus, Nafeesa, J. Andrew Hansz, and Paul J. Kennedy, 2012, Dynamic interactions between private and public real estate markets: Some international evidence, *Journal of Real Estate Finance and Economics* 45, 1021–1040. 38

A. Robustness: Tail Risk Properties of REITS

A.1. Measuring Left-Tail Macro-economic Risk

We obtain two data series to explore whether REITS hedge macro-economic tail risk. The first series comes from a Siriwardane (2015) who uses the cross-section of equity options to back out the probability of a macro-economic disaster. The data are monthly from January 1996 until May 2015 (233 months). We call his probability of a disaster the S disaster prob. We calculate monthly changes in the variable and call the resulting series the S factor. This factor is what we will use in my asset pricing tests.

The second time series is from Giglio, Kelly, and Pruitt (2016). They consider a dozen measures of financial fragility and extract from these measures the single factor that best forecasts the left tail of macro-economic activity using quantile regression techniques. They refer to their variable as PQR. We call their level variable the GKP macro pred. It is always negative, and more so the lower the left tail of macro-economic activity is predicted to be. We construct an asset pricing factor by taking changes of this measure, the GKP factor. The series is available from the start of my sample in January 1972, but ends in December 2011 (480 months).

A.2. Measuring Systemic Risk in Financial Intermediation

The intermediary-based asset pricing literature has taken the stance that financial intermediaries (such as primary brokers) are the marginal investors in many asset markets. In a well-known paper, He, Kelly, and Manela (2017) develop a risk factor which captures the systematic risk associated with declines in intermediary equity capital. Their HKM Interm. Cap. ratio is strongly pro-cyclical, declining precipitously in financial crises like the Great Financial Crisis of 2008-09. The HKM factor is the change in this intermediary equity capital ratio divided by the lagged ratio. They show that this intermediary risk factor does a good job pricing a wide range of asset classes (cross-section of equities, Treasuries sorted by maturity, corporate bonds, CDS, options). This set includes assets that may share some of the lower-liquidity features of REITS. Their risk factor is motivated by the theoretical work in He and Krishnamurthy (2013, 2014) and Brunnermeier and Sannikov (2012), among others. We use the *traded* intermediary capital risk factor of He, Kelly, and Manela (2017), which is the value-weighted stock market return of primary brokers, as my main measure of the HKM factor. This has the advantage that the market price of risk for the factor is equal to the sample average excess return on the factor. The asset pricing results are robust to using their non-traded factor; the correlation between the two series is 92%. This series is available over the entire 1972-2016 period (540 months).

A.3. Correlation Analysis

First, we show the correlation between the three level variables and between the three factors (which are the changes in the level variables). For each pairwise correlation, we use the maximum available overlap (480, 233, and 192 observations, respectively). This implies these correlations are computed for different periods. Table A.I shows the result. The top panel is for the level variables, the bottom panel from the changes. All correlations have the expected sign. When disasters are likely, the intermediary equity capital ratio is low (-18%). When the left tail of macro-economic outcomes is expected to be very low (negative), the intermediary capital ratio is also unusually low (+25%). Finally, when left-tail macro outcomes are predicted to be poor, disaster probability is high (-64%). The results are similar in Panel B, which reports the correlations between the three factors. Since the mutual correlations are far from perfect, there is independent information in each

Table A.I: **Correlation Among Fragility Measures**

	Panel A: Levels		
	HKM Interm Cap ratio	S disaster prob	GKP macro pred
HKM Interm Cap ratio	1		
S disaster prob	-0.18	1	
GKP macro pred	0.25	-0.64	1
	Panel B: Changes		
	HKM factor	S factor	GKP factor
HKM factor	1		
S factor	-0.28	1	
GKP factor	0.12	-0.41	1
	Panel C: Correlation with REIT excess returns		
	HKM factor	S factor	GKP factor
01/1972-12/2016	0.56		
01/1996-05/2015	0.58	-0.42	
01/1972-12/2011	0.59		0.25
01/1996-12/2011 0.62	-0.44	0.33	

Panel C of Table A.I shows the correlation between the three fragility factors and REIT excess returns. Column 1 shows that REITS have positive excess returns when intermediaries see improvements in their equity capitalization, and negative returns when intermediary equity capital ratio deteriorates. Similarly, REIT excess returns are negative when the disaster probability increases (column 2). Finally, REIT returns are low when the left tail prediction for macro-economic activity is revised down (column 3). The results are consistent across samples. In other words, REITS are exposed to all three fragility measures rather than a hedge for them. The tail-risk or intermediary capital-risk hedging explanations seem to go the wrong way to explain the high observed REIT prices. Still, it is worth exploring them more formally in the context of the multi-variate asset pricing models.

A.4. Asset Pricing with the HKM Factor

Unconditional Analysis   Table A.II shows our main asset pricing results with the HKM intermediary equity capital risk factor. Since the factor is available for the full 1972-2016 sample, we use the full sample period in estimation. We take the log of the intermediary capital return and subtract the risk-free rate so as to construct the log excess return, like we do for all other factors. The first and second column repeat the results from the main text with the stock market and bond market factors. The third column features the stock market factor and the HKM factor. This is the two factor model of He, Kelly, and Manela (2017). Columns (3) and (4) shows that REITS show significant exposure to the intermediary capital risk factor, in addition to the stock market factor or to the stock and bond factors. The exposures in both columns are 0.17 with a t-stat of 2.87 and 2.77. The explanatory power of the 2-factor model improves only modestly when we add the intermediary factor. The R^2 goes from 36.75% to 38.44%. Multiplying the HKM exposure of REITS

by the average excess return on the HKM factor of 4.8% per year adds 80 basis points to the expected return However, the inclusion of the HKM factor substantially lowers the stock market beta of REITS: from 0.66 to 0.46. The lower equity market exposure lowers the expected rate of return on REITS by 105 basis points. The last row of the table shows that the net effect is that the expected return of REITS falls from 8.36% to 8.06% per year. This change is far too small to explain our results.

Table A.II: **Unconditional REIT Factor Model with HKM Factor**

The dependent variable is the excess return on the equity REIT index. The independent variables are listed in the main text. The first row reports the intercept α, the other rows report risk factor exposures β. The last factor is the traded intermediary equity capital risk factor of He, Kelly, and Manela (2016), "HKM," expressed as a log excess return. The t-statistics are computed using Newey-West standard errors with one lag. The last but one row reports the R^2 of the regression. The last row reports the expected return according to the regression model. It includes the risk-free rate and excludes the alpha. The data are monthly from January 1972–December 2016.

	(1)	(2)	(3)	(4)	(5)	(6)
α	3.12	2.92	3.38	3.22	−0.09	−0.02
t-stat	1.43	1.34	1.60	1.51	−0.04	−0.01
β^s	0.66	0.66	0.46	0.46	0.67	0.65
t-stat	9.37	9.16	5.96	5.97	10.59	7.73
β^b		0.09		0.07	0.21	0.21
t-stat		0.93		0.71	2.64	2.57
β^{smb}					0.41	0.41
t-stat					7.90	7.77
β^{hml}					0.55	0.53
t-stat					6.39	6.14
β^{mom}					−0.06	−0.06
t-stat					−1.18	−1.15
β^{HKM}			0.17	0.17		0.02
t-stat			2.87	2.74		0.47
R^2	36.58	36.75	38.34	38.44	52.56	52.58
Exp. ret.	8.16	8.36	7.90	8.06	11.36	11.30

Column (5) repeats the five-factor model in the paper and column (6) adds the HKM factor to it. After controlling for stock, bond, size, value, and momentum factors, we see that REITS have essentially zero exposure to the HKM factor (0.02 exposure). The HKM factor exposure also loses its statistical significance. Including the HKM factor changes the factor loadings on the first five factors only very slightly. The overall effect from including the HKM factor is that the expected return falls from 11.36% to 11.30%. In sum, REITS are exposed to the risk of the deterioration in intermediary capital, rather than hedging that risk. After accounting for how the HKM factor affects all other risk exposures, the total risk premium for REITS is only marginally lower. The minor reduction in the expected REIT return cannot help explain the high prices of REITS.

Conditional Analysis We investigate the possibility that REITS have time-varying exposure to the intermediary capital risk factor. In particular, it could be the case that REITS became a hedge for this systematic risk associated with financial intermediation over the last 5-6 years, despite having a positive exposure to the risk factor over the full sample. We augment the dynamic five-factor model with the HKM fragility factor:

$$x_t^{5f+HKM} = E_t[r_{t+1}] = r_t^f + \beta_t^s \Lambda^s + \beta_t^b \Lambda^b + \beta_t^{smb} \Lambda^{smb} + \beta_t^{hml} \Lambda^{hml} + \beta_t^{mom} \Lambda^{mom} + \beta_t^{HKM} \Lambda^{HKM}, \quad (A.1)$$

We estimate the factor betas from multi-variate regressions over 60-month rolling windows. Since all factors are traded, the market prices of risk are the average excess returns on the factors. Figure A.1 plots the contribution of each of the seven terms in equation (A.1): the risk-free rate and the six risk premia.
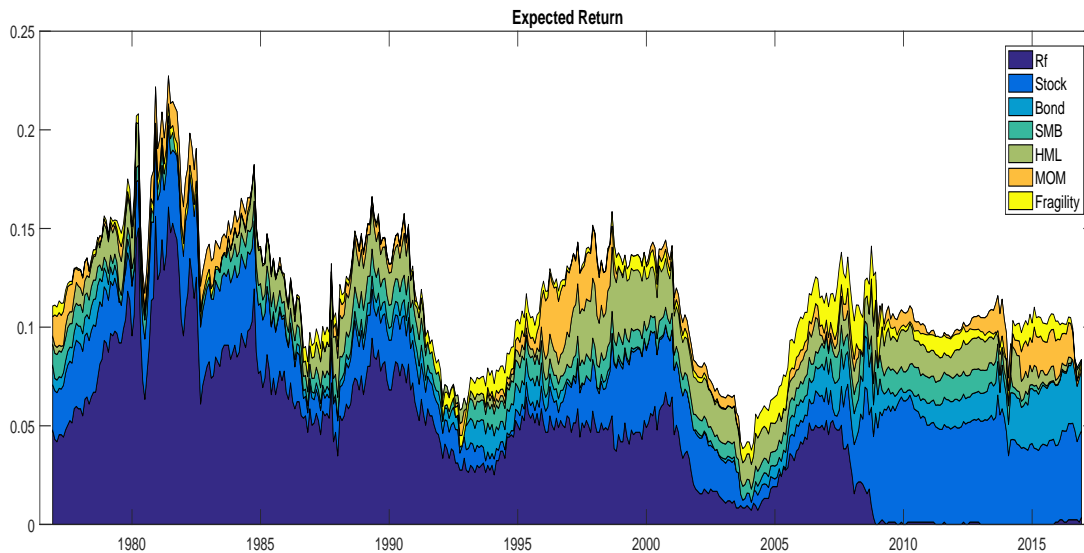

Figure A.1: Expected Return of REITS in Five-Factor Model Augmented with HKM Factor
The figure plots the expected return on REITS as implied by the five-factor model plus the HKM factor in equation (A.1). The betas on the factors are estimated on 60-month rolling windows. To calculate the risk premium, we multiply each beta with the average excess return on the factor over the full 1972–2016 sample.

The contribution of the HKM factor to the risk premium of REITS is indicated by the yellow area labeled "Fragility." Compared to the other risk factors, the contribution from the HKM factor is fairly minor. The exposure to the fragility factors is largest in the windows that include the financial crisis in 2007-09. The fragility beta then falls but never inverts. Adding the HKM factor to the five-factor model increases the expected return relative to the five-factor model over the last six or seven years of the sample. This deepens the puzzle of the high REIT prices during those years.

A.5. Asset Pricing with the S Factor

Market Price of Risk Next, we turn to the disaster probability factor of Siriwardane (2015), extracted from the cross-section of options. A challenge with both this factor and the GKP factor studied below is

that they are non-traded factors. Therefore, the market price of risk Λ^S is not simply the average of the S factor. Siriwardane (2015) sorts stocks into quintiles based on their exposure to the changes in the disaster probability (disaster betas) and computes average returns for these disaster-beta quintiles. The ratio of the excess return difference between Q5 and Q1 and the beta difference between Q5 and Q1 is the market price of risk $\Lambda^S = -0.2855$ per year. We use this value when calculating the annual expected return. The negative market price of risk is natural since an increase in disaster probabilities represents a deterioration of the investment opportunity set for the representative investor.

Unconditional Analysis Table A.III shows our main asset pricing results with the macro-economic disaster or "S factor." This factor is only available for 1996-2015, so we focus on that period. Column (4) shows that REITS have a significant and negative exposure to increases in the disaster probability. In other words, REITS perform poorly when left-tail risk rises. REITS fall between the second highest and highest disaster risk quintiles reported in Siriwardane (2015). This finding remains true after controlling for other factors in column (6). REITS are exposed to tail risk, rather than hedging it.

Adding the S factor to the model with stocks and bonds (comparing columns 4 to 2), increases the expected return by 150 basis points. Adding the S factor to the 5-factor model (comparing columns 5 and 6) adds 120 basis points. The equity beta shrinks a bit but the substantial exposure of REITS to left-tail risk leads to a significant increase in the overall risk premium. The tail risk factor also adds a non-trivial 4.7 percentage points to the R^2 of the five-factor model. In sum, accounting for the exposure to disaster risk deepens the puzzle of the low expected return of REITS, or equivalently, the high price of REITS.

Conditional Analysis We investigate the possibility that REITS have time-varying exposure to the disaster risk factor. In particular, it could be the case that REITS became a hedge for macro-economic disasters over the last 5-6 years, despite being exposed to the risk over the full sample. We augment the dynamic five-factor model with the fragility factor from Siriwardane (2015):

$$x_t^{5f+S} = E_t\left[r_{t+1}\right] = r_t^f + \beta_t^s \Lambda^s + \beta_t^b \Lambda^b + \beta_t^{smb} \Lambda^{smb} + \beta_t^{hml} \Lambda^{hml} + \beta_t^{mom} \Lambda^{mom} + \beta_t^S \Lambda^S, \qquad (A.2)$$

Figure A.2 plots the contribution of each of the seven terms in equation (A.2). The first 60-month estimation window ends in December 2000, which is why the graph starts at that point. The contribution of the S factor to the risk premium of REITS is indicated by the yellow area labeled "Fragility." Compared to the other risk factors, the contribution from the S factor is substantial especially in the windows that include the financial crisis. Adding the S factor to the five-factor model increases the expected return relative to the five-factor model over the last six or seven years of the sample. This deepens the puzzle of the high REIT prices during those years.

A.6. Asset Pricing with the GKP Factor

Market Price of Risk Finally, we turn to the Giglio, Kelly, and Pruitt (2016) measure, which is the innovation in the best quantile predictor of macro-economic stress. For the purposes of calculating the expected return, the question arises what the appropriate market price of risk is for the GKP factor. Since its asset pricing implications have not been studied before, we do a preliminary cross-sectional asset pricing analysis to estimate the market price of risk Λ^{GKP}. We use a rich set of 40 test assets, comprised of the value-weighted stock market, 10 book-to-market sorted stock portfolios, 10 size-sorted stock portfolios, 10 stock portfolios sorted by operating profitability, 5 government bond portfolios sorted by maturity, and 4

Table A.III: **Unconditional REIT Factor Model with S Factor**

The dependent variable is the excess return on the equity REIT index. The independent variables are listed in the main text. The first row reports the intercept α, the other rows report risk factor exposures β. The last factor is the change in the probability of a macro-economic disaster, extracted from the cross-section of equity options by Siriwardane (2015), the "S" factor. The t-statistics are computed using Newey-West standard errors with one lag. The last but one row reports the R^2 of the regression. The last row reports the expected return according to the regression model. It includes the risk-free rate and excludes the alpha. The data are monthly from January 1996–May 2015.

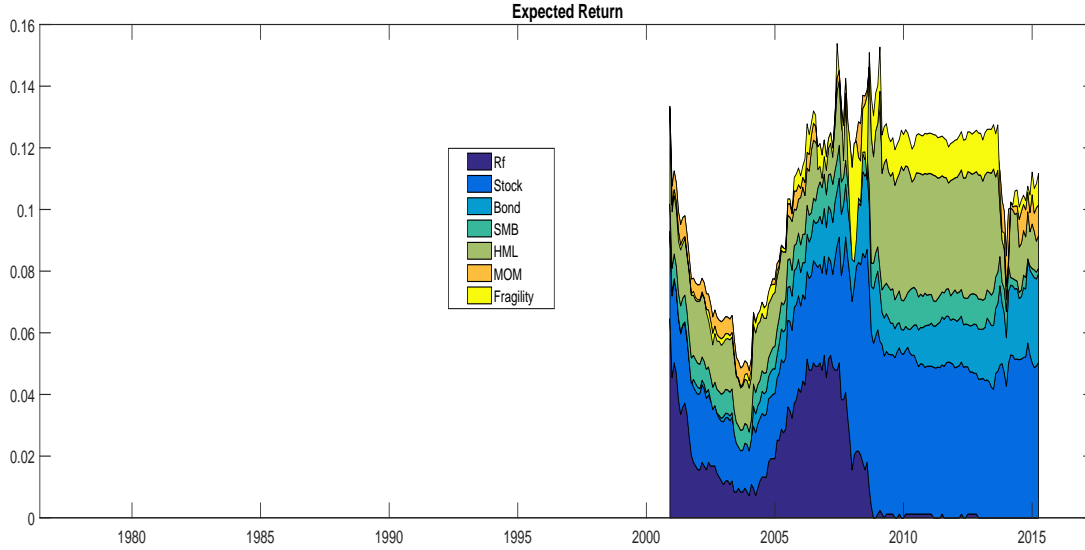|	(1)	(2)	(3)	(4)	(5)	(6)
α	3.57	2.37	2.61	0.86	-0.60	-1.80
t-stat	0.83	0.53	0.68	0.21	-0.17	-0.56
β^s	0.75	0.78	0.64	0.68	0.77	0.70
t-stat	5.21	5.46	4.80	4.96	7.30	8.75
β^b		0.33		0.46	0.52	0.59
t-stat		1.37		2.22	3.13	3.86
β^{smb}					0.53	0.49
t-stat					6.99	6.87
β^{hml}					0.81	0.79
t-stat					7.87	7.27
β^{mom}					-0.12	-0.08
t-stat					-2.15	-1.53
β^S			-5.57	-6.03		-4.68
t-stat			-1.74	-2.08		-2.81
R^2	32.75	33.87	39.92	42.08	58.98	63.67
Exp. ret.	6.83	8.02	7.78	9.53	10.99	12.20

Figure A.2: Expected Return of REITS in Five-Factor Model Augmented with S Factor

The figure plots the expected return on REITS as implied by the five-factor model plus the "S factor" in equation (**??**). The betas on the factors are estimated on 60-month rolling windows. To calculate the risk premium, we multiply each beta with the average excess return on the factor over the full sample.

corporate bond portfolios sorted by credit rating. We use a three factor asset pricing model to price these 40 test assets, comprised of the stock market factor, the bond market factor, and the GKP factor. The data are from January 1980 (the first month the credit portfolios are available) to December 2011 (the last month the GKP factor is available). In a first stage, we estimate the three factor betas for each of the 40 test assets using a time series regression of the excess return on the test assets on the factor returns and a constant. In the second stage, we regress the average excess returns on the test assets on the betas from the first stage and a constant, to estimate the market prices of risk. We obtain a market price of GKP risk of $^{GKP} = 0.0018$ per month (or 2.2% per year) with a t-stat of 2.47. The market prices of stock and bond market risk are 0.33 and 0.26, with respective t-stats of 4.66 and 4.16. The mean absolute pricing error among the 40 test assets is 1.75 percent per year, which is small relative to the mean absolute average return of 5.26 percent per year. In other words, this three-factor model explains most of the cross-sectional variation in excess returns among the rich cross-section of stock and bond test asset returns. In robustness analysis, we find similar Λ^{GKP} estimates for variations in the set of test assets. We use the value of $^{GKP} = 0.0018$ in the REIT pricing exercise below. A positive price of risk means that a positive GKP factor reading is good news for the marginal investor –a low marginal utility of wealth state– since the likelihood of a macro-economic disaster has receded.

Unconditional Analysis Table A.IV shows our main asset pricing results with the GKP macro-economic disaster risk factor. Since the factor is available for the 1972-2011 sample, we use this sample period in estimation. Columns (3) and (4) show that REITS have a positive exposure to the GKP factor, just as they did in the univariate correlation analysis above. In other words, REITS do well when macro-economic tail risk recedes and do poorly when macro-economic tail risk increases, after controlling for their stock and bond exposure. Their tail risk exposure is statistically significant (t-stat of 2.20) and the regression R^2 goes up modestly from 37.77% to 40.12%. The GKP factor exposure adds 3.5 percentage points to the overall risk

50

premium of REITS. It only marginally lowers the stock and bond exposure so that the net effect is a 334 basis points higher expected return.

Columns (5) and (6) show that the significance of the GKP factor is fragile to the inclusion of size, value, and momentum factors. The GKP factor beta loses its significance as well as nearly half of its magnitude. The overall expected return still rises significantly, from 11.55% per year in column (5) to 13.47% in column (6), an increase of 190 basis points. In sum, REITS do poorly when macro-economic tail risk increases. Taking this into account increases the return investors ought to be getting for investing in REITS. This tail-risk exposure deepens the puzzle as to why REITS are so expensive.

Table A.IV: **Unconditional REIT Factor Model with GKP Factor**

The dependent variable is the excess return on the equity REIT index. The independent variables are listed in the main text. The first row reports the intercept α, the other rows report risk factor exposures β. The last factor is the change in the PQR variable from Giglio, Kelly, and Pruitt (2016), or "GKP" factor. The t-statistics are computed using Newey-West standard errors with one lag. The last but one row reports the R^2 of the regression. The last row reports the expected return according to the regression model. It includes the risk-free rate and excludes the alpha. The data are monthly from January 1972–December 2016.

	(1)	(2)	(3)	(4)	(5)	(6)
α	3.12	2.92	3.38	3.22	-0.09	-0.02
t-stat	1.43	1.34	1.60	1.51	-0.04	-0.01
β^s	0.66	0.66	0.46	0.46	0.67	0.65
t-stat	9.37	9.16	5.96	5.97	10.59	7.73
β^b		0.09		0.07	0.21	0.21
t-stat		0.93		0.71	2.64	2.57
β^{smb}					0.41	0.41
t-stat					7.90	7.77
β^{hml}					0.55	0.53
t-stat					6.39	6.14
β^{mom}					-0.06	-0.06
t-stat					-1.18	-1.15
β^{GKP}			0.17	0.17		0.02
t-stat			2.87	2.74		0.47
R^2	36.58	36.75	38.34	38.44	52.56	52.58
Exp. ret.	8.16	8.36	7.90	8.06	11.36	11.30

Conditional Analysis Finally, we augment the dynamic five-factor model with the GKP fragility factor:

$$x_t^{5f+GKP} = E_t\left[r_{t+1}\right] = r_t^f + \beta_t^s \Lambda^s + \beta_t^b \Lambda^b + \beta_t^{smb} \Lambda^{smb} + \beta_t^{hml} \Lambda^{hml} + \beta_t^{mom} \Lambda^{mom} + \beta_t^{GKP} \Lambda^{GKP}, \qquad \text{(A.3)}$$

We estimate the factor betas from multi-variate regressions over 60-month rolling windows. Figure A.3 plots the contribution of each of the seven terms in equation (A.3). The contribution of the GKP factor to the risk premium of REITS is substantial, including and especially at the end of the sample. Since the data end in December 2011, we do not have any estimation windows here that are completely post-crisis. However, throughout the sample, the GKP risk factor compensation increases the expected return on REITS relative to the five-factor model. Again, we conclude that this deepens the puzzle of the high REIT prices during those years.
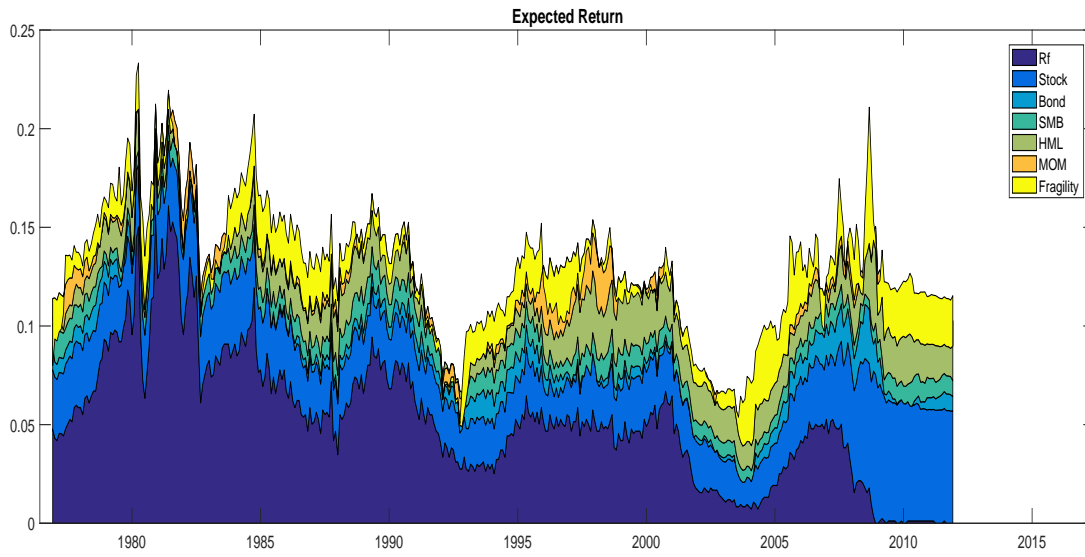

Figure A.3: Expected Return of REITS in Five-Factor Model Augmented with GKP Factor
The figure plots the expected return on REITS as implied by the five-factor model plus the GKP factor in equation (A.3). The betas on the factors are estimated on 60-month rolling windows. To calculate the risk premium, we multiply each beta with the average excess return on the factor over the full sample.