The Interest Rate Sensitivity of Public Real Estate

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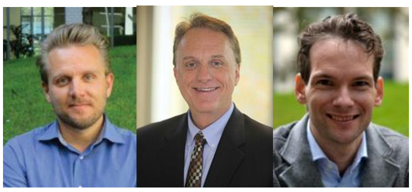

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0 Executive summary

We analyse the interest-rate sensitivity of international listed real estate at a time when institutional investors are confronted with low coverage ratios and the glooming prospect of an increase of the current historical low in interest rates. At times, when returns are low or uncertain, interest rate movements matter more. For fixed income assets, duration is typically used to assess the interest rate exposure of investments. For public real estate investments, no conclusive evidence is available that explains the relevance and variation in interest rate sensitivity on an individual firm level.

In this paper, we provide empirical evidence regarding the interlink between public real estate returns and interest rate dynamics, for 723 listed real estate investment companies in 10 markets for the period 1999-2015. Our analysis consists of three stages. First, we analyse the interest rate risk loading of individual firms using a standard two factor asset pricing model. The resulting interest rate beta's differ widely across firms and changed gradually over our sample period. Overall, it seems that the interest rate sensitivity of public real estate increase when credit is tight and more expensive. We continued our analysis with sorting our sampled public real estate companies into decile portfolio based on their interest rate beta's and documented a return premium of 3.47% a year across the high versus low risk portfolios. This shows, that interest rate sensitivity does not only differ across firm, but that it also leads to a variation in subsequent returns. It pays off to know the interest rate beta of a listed real estate firm, as future returns are set accordingly. Finally, we also examined the firm characteristics of public real estate that may help to explain the observed variation in the firm level interest rate beta's. Why are some firms more sensitive to interest rate risk than other. Our empirical results confirm what the available literature indicated before. We find that interest rate sensitivity is stronger for firms with large fractions of short debt maturities and low occupancy rates in their property portfolios. Results that are in line with the cash flow concept of duration, since shorter term debt enhance the exposure of a firm to the swings of interest rates.

The implication of these results are relevant for a wide audience. For public real estate firm management, our results indicate that capital structure management gains relevance, since subsequent stock returns are related to how (and how much) firms are levered. For investors, our results show that it is important and relevant to include the details of interest rate sensitivity into their due diligence process, as a premium can be earned and lost due to the ex-post exposure to interest-rate risks. Finally, our results also have implication for the academic literature as we provide evidence that shows that research on interest rate risk for non-fixed income investments is needed. Also beyond the concept of duration, new metrics may well be needed to capture and examine why interest rate risk differs across firms and over time. More research is needed to disentangle this interest rate impact on stock returns and to design metrics that succeed in capturing price relevant interest rate risk ex-ante.

1 Introduction

In this paper, we analyse how future changes in interest rates affect public real estate returns. Investors care about interest rate risks for several good reasons. The current record low levels of interest rates induce concerns regarding the deteriorating effects that future interest rate increases may have on their investment portfolios. Given that institutional investors are already facing low funding ratios in their asset liability management, negative shocks due to interest rate jumps are on the top of risk management agendas. Typically, institutional investors formulate explicit investment policies regarding interest rate risk exposure and seek assets that help them to contend with the negative effects of this uncertainty. In the case of their fixed income investments, investors make use of well-established metrics like duration to measure and manage their exposure to interest rate risk. While for other investment categories clear measures and conclusive insights are still largely absent.

Examining the effects of interest rate risk for real estate investments is especially interesting for several reasons. First, real estate investments have a cash flow structure that resembles fixed income securities. Long-term lease contracts often produce relatively predictable cash inflows, which can be tracked in a relatively transparent market. As such, analysing the effects interest rate changes on real estate investment values is much more straightforward than for common stocks, where the complexity of the cash flow structure limits the application of a duration framework. Furthermore, real estate investments – both public and private – typically involve the use of large quantities of debt. Leverage increases exposure to interest rate risk. Within the international listed real estate markets, corporate debt levels and structures varies vastly across individual firms, which offers an interesting laboratory for empirical research. These first two reasons have inspired other authors to study the interest rate effects on listed real estate returns. Allen et al. (2000) examine whether U.S. REIT returns respond to changes in both the general stock market and interest rates, but reported results that lacked statistical significance due to sample size limitations. He et al. (2003) extended their work by stressing the importance of accurate and relevant interest-rate measurement. They estimate the interest-rate sensitivity of individual U.S. REITs over a longer time series using seven different interest-rate proxies, ranging from short-term government bonds to long term low-grade corporate bonds. Their results differ widely depending on the choice of proxy. Finally, Stevenson et al. (2007) examined the sensitivity of real estate securities to changes in both market- and central bank interest rates. Their results, which were the first to examine the U.K. listed property sector illustrate that this sensitivity is not confined to periods of high and volatile interest rates as the sample period under examination is characterized by historically low and stable rates. We believe that our study can make a valuable contribution to the available literature, due to the third and final reason. In the past fifteen years very relevant changes have occurred in the market. Listed real estate markets around the world have matured into a trillion dollar investment sector, which has expanded our degrees of freedom. Moreover, we have witnessed a global financial crisis, which has stressed the importance of the availability and price of corporate debt in the real estate markets. Therefore, in this study, we focus on how the returns of listed real estate investments around the world have react to changes in interest rates and examine the key determinants of these price reactions for the period 1999-2015..

Although duration is not directly applicable to public real estate investments because of their infinite lives and their combination and uncertain cash flow, we identify specific interest rate related balance sheet characteristics and analyse whether variations in these characteristics explain why the returns of some listed real estate firms are more sensitive to interest rate movements than that of others. These firm characteristics include leverage, loan maturities, debt structure and costs, vacancy rates, and property type specialization. We test our results for robustness by stratifying our sample across regions and time periods.

Our empirical analysis of the importance of interest rate movements consists of three steps. First, we examine the risk-return characteristics of public real estate firms. Here we estimate a firm-level return sensitivity to interest rate factors, while controlling for market risk. If listed real estate returns are sensitive to an interest rate factor, it suggests investors recognized and valued the importance of the interest rate exposure ex-post. To test whether these firm specific loadings of interest rate sensitivities are also indicative for future return patterns, we sort our sampled firms into five deciles based on estimated interest rate beta's and compare their subsequent returns and market risks. We perform this analysis on a rolling basis for various return horizons. This allows us to identify whether interest rate risk is associated with market risk and whether variations in interest rate risk exposures are predictive of returns. In the third and final stage of our empirical analysis, we examine the extent to which firm-level interest rate betas can be explained by firm specific characteristics. We try to identify the most important firm specific factors that help to understand why interest rate sensitivity vary across listed real estate firms. Firm characteristics that can eventually help investors to select their listed real estate investment in order to enhance or reduce their interest rate risk exposure.

Our results can be summarized as follows. First, our two factor asset pricing model produces interest rate beta's that differ widely across firms and vary significantly over time. Overall, interest rate loadings tend to increase when credit is tight and expensive. After annually sorting our sampled listed real estate firms into deciles based on their interest rate betas, we document a return premium of 2.11% per year across the high-versus-low risk portfolios. This suggests interest rate risk exposure differs across listed real estate firms and leads to variations in their returns. That is, interest rate risk is priced at a premium that changes over time. We measured the highest interest rate risk premiums during the periods when credit was less scarce. Finally, we identify specific real estate firm characteristics that help explain the observed variation in firm level interest rate betas. As expected, we find that interest rate sensitivity is greater among listed real estate firms with higher debt rates and shorter debt maturities. These results are consistent with the cash flow concept of duration, since more debt and shorter maturities enlarge the refinancing exposure of a firm to the swings of interest rates. We also find that the interest rate sensitivity is lower among large firms and those with high occupancy rates in their real estate portfolios. Firm size has been identified as a good proxy for access to capital. Larger firms have more negotiating power when (re)financing their debt, than smaller competitors. Hence, in this case being larger than average may well offer an advantage during loan renegotiations, especially when interest rates have changed. High occupancy rates strengthen the cash flows of firms and make their present valuation less sensitive to changes in the interest rate.

The paper proceeds with a discussion of the literature that has motivated our conceptual framework for examining the interest rate sensitivity of international listed real estate. After discussing our international dataset and return models, we present our interest rate sensitivity estimate. We then discuss the results from our interest rate beta portfolio sortings. Finally, we present our results for the cross sectional analysis of the interest rate coefficients of individual REITs to identify the key factors that explain why this sensitivity varies over time and across firms. We conclude with a summary of our key findings and their implications.

2 Interest Rates, Asset Prices and Public Real Estate

The literature on interest rate sensitivity is rich and very large. In this section, we offer an overview of the most relevant literature that inspired our empirical analysis. We start with a brief discussion of the concept of duration and the way we identify relevant firm characteristics for explaining interest rate sensitivity based on this concept. We then discuss ways in which interest rate risk has been included and estimated in the asset pricing literature, and conclude with a discussion of the listed real estate analyses of interest rate risk that have preceded us.

2.1 Duration

The interest rate sensitivity of asset prices has been a concern of both the investment community and the corresponding academic literature for almost a century. In 1938, Macaulay introduced the concept of duration (D), defined as the weighted average term to maturity of the cash flows of a bond. In the calculation of duration, the weight of each cash flow (c) is determined by dividing its present value, when discounting at a rate of (k), by the price (P).

$$D_0 = \frac{1}{P_0} \int_{t=0}^{\infty} t \, E_0[c_t] e^{-kt} dt \qquad (1)$$

Duration serves as a measure of bond price sensitivity with respect to interest rates, as changes in the interest rates trigger adjustments in their discount rate. During the past seventy years, duration has maintained its position as a key measure of interest rate risk in the fixed income investment market. Its widespread application has inspired authors like Cornell (1999) and Dechow et al. (2002) to propose extensions of bond duration to equity shares, generally termed equity duration. Similar to bond duration, equity duration is the weighted average time at which shareholders expect to receive their cash flows from an investment in a company's share. The expected cash flows E0[ct] for fixed rate bonds consist of a predetermined stream of promised coupon payments and the return of the maturity value. However, equity investments offer a claim to a potentially infinite stream of dividend payments that are generally less predictable. These dividends are a function of a firms' operational performance and management's dividend payout policy. For most firms, this operational performance involves a plethora of flows of costs and income, which are affected in various ways by exogenous shocks to their firm and industry. Moreover, in the case of equity duration these cash flows are discounted at a share's implied equity yield (k). This implied equity yield is similar to a bond's yield to maturity, as it equates the current share price to the discounted expected cash flows.

This equity duration, however, is a much broader concept than Macaulay's (1938) duration for fixed income securities. In the case of equity duration, we must model and measure a stock's price sensitivity to changes in the implied equity yield, which is driven by more factors than interest rates. For equities, changes in interest rates are very relevant, but so are changes in risk premiums, which may alter equity yield in periods of interest rate stability. Hence, instead of directly measuring equity duration, we include various elements from this cash flow concept to help explain and disentangle interest rate sensitivity at the firm level, using validated asset pricing model specification. We thereby combine elements from two strands of the literature: the measurement quality of interest rate risk from the asset pricing literature and the conceptual quality of the equity duration framework to identify firm specific characteristics that can help explain interest rate sensitivity.

2.2 Interest rates in asset pricing models

Sharpe (1964) and Lintner (1965) developed the capital asset pricing model (CAPM) that states that a stock's nominal return in excess of the risk-free rate is a linear function of its systematic market risk. Numerous related studies have attempted to further develop the theory of stock pricing; moreover, numerous empirical studies have attempted to explain the time series and cross section of stock returns. These studies normally focus on a particular type of firm whose returns may be driven by multiple systematic risk factors. In other words, the single-factor model derived from the CAPM has largely been replaced by multifactor asset pricing models.

Interest rate risk has been identified as a potential additional factor that may help to improve our understanding of asset pricing. Stone (1974) developed a two-factor pricing model for explaining stock returns that contains an interest-rate proxy to compliment the proxy for market risk. The inclusion of an interest-rate proxy implies the effects of interest rate changes on returns are not completely captured by movements in the market risk factor. The need for a two-factor model to capture exposure to interest-rate movements is supported by studies documenting an inverse relationship between inflationary expectations and stock returns. If changes in interest rates are linked to changes in inflationary expectations (see Fama, 1976), then interest rate movements should be inversely related to stock returns (see Bae, 1990, and Boons et al, 2016).

The two-factor pricing model developed by Stone (1974) is most relevant for assessing the market value of firms with operating characteristics that can cause a pronounced exposure to interest-rate movements. Various forms of the two-factor model have been applied by Lynge and Zumwalt (1980), Flannery and James (1984), Bae (1990), and others to explain the time series of returns for various types of financial institutions. Flannery and James argue that firms holding financial assets should be more sensitive to interest-rate movements, especially when their maturity (and therefore their market pricing structure) of their liabilities differ from that of their financial assets.

Short-term interest rates are considered an extra market factor in two-factor models because they may serve as a proxy for changes in the cost of funds for financial institutions that heavily rely on deposits or other money-market instruments to finance their assets. In contrast, long-term interest rates serves as alternative extra market proxies because they contain implied market expectations of interest rates in the future (forward rates), which may also imply a level of anticipated inflation. To the extent the pricing of liabilities or assets of financial institutions are conditioned on changes in forward interest rates or anticipated inflation, a shift in the long-term interest rate may elicit the repricing of the financial institution's value. Similar to financial institutions, many listed real estate investment firms make extensive use of leverage, much of it with short maturities, to finance long-term investments in commercial real estate.

2.3 Interest rate risk of Public Real Estate

We focus on listed real estate in our empirical analysis, because listed real estate firms offer an interesting laboratory for our examination because they combine a relatively transparent cash flow structure and tangible assets, with wide variation in corporate capital structures. The variation in leverage allows us to compare estimations of equity duration and interest rate sensitivity for individual firms and determine the extent to which differences in cash flow characteristics and capital structures affect interest rate sensitivity.

We are not the firsts to analyze the link between real estate returns and changes in the interest rate. Allen et al. (2000) examine whether U.S. REIT returns respond to changes in both the general stock market and interest rates. They also examine whether differences in asset structure, financial leverage, management strategy, and degree of portfolio specialization are related to the estimated interest rates betas. Their empirical results, however lack statistical significance and are not generalizable because they focus on a limited sample of U.S. REITs. Moreover, this early analysis lacked variation in financial market regimes. In particular, no major financial events or crises occurred during their sample period. Brown (2000) applies the duration of a conventional valuation model to estimate the ex-ante volatility and total risk of the commercial property market in the U.K. Interest-rate sensitivity is measured as the percentage value changes of properties due to a 100 basis point change in interest rates. The analysis strongly relies on professional valuers (appraisers) to make forecasts of changes in required yields.

He et al. (2003) extends this literature by stressing the importance of accurate and relevant interest-rate measurement. They estimate the interest-rate sensitivity of individual U.S. REITs over a longer time series using seven different interest-rate proxies, ranging from short-term government bonds to long term low-grade corporate bonds. Their results differ widely depending on the choice of proxy. Finally, Stevenson et al. (2007) examine the sensitivity of real estate securities to changes in both market and central bank interest rates. Their results, which were the first to examine the U.K. listed property sector, highlight the impact of interest rates on U.K. property companies, in relation to both returns and volatility. Their paper also illustrates this sensitivity is not confined to periods of high and volatile interest rates as the sample period under examination is characterized by historically low and stable rates.

Although equity REITs as a sector have distinct characteristics, an individual REIT's sensitivity to interest-rate movements may vary for different reasons. Allen et al. (2000) list four REIT characteristics that may help explain variations in interest rate sensitivities. First, investment in commercial real estate relies heavily on borrowed funds; thus, the value of real estate and firms that invest in it can be influenced by the cost of debt financing, which affects affordability and investment demand. An upward movement in interest rates may result in reduced aggregate demand for real estate ownership and therefore lower valuations. Second, because increases in market-interest rates typically produce a higher cost of debt financing. Third, because real estate investors derive required equity returns from the comparable maturity risk-free rate and a risk premium, increases in market interest rates drive higher required rate of returns, which reduces property valuations. Fourth, the interest carry associated with the development of real estate varies with interest rates.

Building on the work of Allen et al (2000), we explore a wide variety of firm specific characteristics that ca help to understand why some listed real estate firms are more interest rate sensitive than others. We expect that interest rate sensitivity increases with the debt rate (H1). Second, we expect the debt structure to matter as well. More specifically, we analyze whether the portion of floating rate debt helps explain interest rate sensitivity. We also examine the extent to which the interaction of high interest rates and large fraction of floating rate debt increases exposure to changes in the interest rate (H2). We additionally explore the importance of the average cost of debt. The lower is this rate the larger will be the expected impact of a change in interest rates (H3). In line with the original notion of bond duration, we also test the relationship between a firm's cash flow structure and their equity duration. We expect equity duration to be longer, and firms to be more interest rate sensitive, when current vacancy rates are high (H4), and when a firm's portfolio is dominated by highly cyclical property types, such as hotels and retail (H5). These expectations are all based on the assumption that if cash flow structures contain a long, late and cyclical flow, the distant future become more important, and thus duration is high.

We contribute to this literature by offering international evidence that includes the post global finance crisis and its aftermath, a period during which interest-rate concerns have become very relevant. Our unique international dataset allows us to assess whether interest-rate sensitivity is recognized and priced by investors, whether this has changed over time, and whether it differs across countries. Moreover, we utilize the cross sectional variation within each national sample to determine which firm characteristics are key to explaining interest-rate sensitivity at the firm level.

3 Methodology and data

3.1 Data

Our data set consists of listed real estate investment companies worldwide. The majority of income generated by such companies is derived from real estate development or investment activities. The firm source list includes the SNL database, GPR database, and the EPRA list of delisted companies. The SNL and GPR database also include delisted companies, which takes care of any survivorship bias in our data. We add companies identified by Kempen Capital Management (KCM) as having substantial income from real estate development or investment that are not included in the other lists. Companies whose income is predominantly from hospitality, such as hotel operators, are excluded from the sample. Companies are also removed if no returns are reported for 30 days. New data is taken into account from the moment it is published. All data is collected weekly for the period 1995-2015.

Summary statistics for our international sample are reported in Table 1. Our sample includes 723 unique listed real estate investment companies from over 10 countries.

The source of the weekly total return data is Factset. Average annualized total weekly returns over the 1995-2015 sample vary from 10.46% in Canada to 19.42% for the 12 Swedish firms in our sample. The annualized standard deviation of the weekly returns ranges from 33.92% in the France to 43.90% in Japan.

We use the weekly change in long-term bond rates to examine the effects of interest rate changes on total returns. We obtained weekly observations of the annual effective rates on long maturity government bond indices per country from the countries website of the national bank. For Australia, Canada, the U.S., Singapore, Hong Kong and Sweden we used the 10yr government bond index, for Japan the 9yr government bond index and for the U.K. the 20yr government bond index .

Table 2 displays annualized averages and standard deviations for these interest rates by country, which we proxy by Government Bond rates in line with Allen et al (2000). The average risk free rate is lower than the long term bond rate in all countries, although this difference is sometimes very small. The international variation is more pronounced, as the average risk free rate ranges from 0.20% in Hong Kong to 4.92% in Australia. The longer term bond yields exhibit a similar international variation. Although the three-month yield tends to be lower than the long term rate, Table 2 also show that risk free rates have generally been more volatile during our sample period.

To complete our dataset for the first stage regression we collect for each country the weekly total returns of the countries MSCI general market index from FactSet. At last we limit the data by removing all week-company observations that have either a market capitalization, obtained from Factset, below 30m USD or a negative book equity, obtained from SNL Financial. Only records with a risk free rate, a long term bond rate, a firm weekly firm return and a market index are included in the sample. The final step is that we limit the dataset by windsorizing the total weekly returns on the 0.5% level.

3.2 Measuring Interest Rate Sensitivity

We employ a multi-factor asset pricing framework to estimate interest rate sensitivities. The two-factor model we estimate as our base case specification is similar to those employed by Stone (1974), Jorion (1990), Allen et al. (2000), Ling and Naranjo (2002), and others . The empirical two-factor model, estimated annually in excess return from using weekly data, is as follows for firm i in a given year:

$$R_{it} - RF_{t,c} = \beta_{iy} + \beta_{iy}^{mkt} * [R_{mkt,t,c} - RF_{t,c}] + \beta_{iy}^{interest} * \Delta IRATE_{t,c} + \mu_{iy} \quad (2)$$

where:

R_{it}	=	total return of firm *i* in week *t*;
$RF_{t,c}$	=	local risk free rate in week *t*;
$R_{it} - RF_{t,c}$	=	excess return of firm *i* in week *t*;
β_{iy}	=	a constant for firm i in year y;
β_{iy}^{mkt}	=	sensitivity (exposure) of firm *i*'s excess returns to excess returns on the local stock market portfolio in year y;
$R_{mkt,t,c} - RF_{t,c}$	=	the excess return in week *t* over the MSCI market index in country c;
$\beta_{iy}^{interest}$	=	exposure of firm *i*'s excess returns to changes in the yield on the interest rate proxy over the prior week;
$\Delta IRATE_{t,c}$	=	the weekly change of the effective long term government bond rate; and
μ_{it}	=	an error term.

The estimated coefficient for $\beta_{iy}^{interest}$ represents the exposure or sensitivity of firm *i's* weekly excess stock return to changes in interest rates from week *t-1* to *t*, controlling for movements in the broad stock market. We require a minimum of 10 observation per annual firm regression. In addition to using contemporaneous changes in the weekly yields on our interest rate proxies as our main variable of interest, we also orthogonalize the weekly change in interest rates against the market return in that week. This orthogonalization produces an interest rate proxy that is uncorrelated with movements in the general stock market.

3.3 Interest Beta Sorted Portfolios

As a next step in our analysis, we dynamically group REITs into quintiles based on their estimated interest rate beta. For every week of our sample period, we re-estimate these beta's over a rolling 52 week period, and compare the average returns of each portfolio over the next year to assess whether interest rate betas are predictive of subsequent return[1]. In other words, is the historic interest rate exposure priced into new returns? We aggregate these average decile returns over the whole sample period.

We also report and compare the average market- and interest rate beta's of each decile group to verify whether this any variation in returns are not merely a reflection of market beta variations. Finally, we state the t-stat, which measure the statistical difference of the returns between high and low.

[1] We also compare return of these sorted portfolios over alternative horizons (1 month, 6 months and 12 months) to assess the persistence and consistency of our results.

3.4 Explaining the Firm-Level Variation in Risk Exposures

We next examine the extent to which interest rate exposures estimated in our first-stage regressions are related to firm characteristics. More specifically, we take the interest rate betas estimated for each firm and year and estimate the following pooled, time-series, cross-sectional weighted least square regressions, where the weights are proportional to the standard errors of the beta estimates from the first- stage:

$$\beta_{iy}^{interest} = \emptyset_0 + \emptyset_1 * Occ_{i,y-1} + \emptyset_2 * VarDebt_{i,y-1} + \emptyset_3 * LtV_{i,y-1} + \emptyset_4 * StDebt_{i,y-1} + \emptyset_5 * MatDebt_{i,y-1} + \varepsilon \quad (4)$$

$\beta_{iy}^{interest}$ is the interest rate beta for firm i in year y; $\emptyset_0$ represents a constant; and $\emptyset_1$ to $\emptyset_n$ are coefficient estimates for the following firm specific characteristics: occupancy (Occ), variable debt (VarDebt), the loan to value (LtV), the short term debt (StDebt) and the maturity of the debt (MatDebt). All firm characteristics are measured at the end of the previous year and obtained from SNL Financial. The occupancy is expressed as a percentage. The variable debt is the percentage of debt with no fixed interest rate. The loan to value is calculated as the total liabilities, obtained from SNL financial, divided by the sum of the total liabilities and the market capitalization of equity obtained from Factset. The short term debt is the percentage of debt of the total debt book that is due within 2 years. The maturity of the debt is the average number of months till maturity of the debt book.

We include time and sector fixed effects. The sector classification is based on the prime sector of the firms real estate based on SNL's classification. The standard errors are clustered by firm (see Petersen, 2009), although robust-White standard errors produce similar results.

4 Results

4.1 Measuring interest rate risk exposure

We report the results of our analyses in three steps. First, we focus on the market and interest rate sensitivity estimates from our first stage regressions, which are estimated at the firm level for each country and are presented in Table 3. In the results reported in Panel A, changes in country specific 10-year bond yields are used as the interest rate proxy. The estimated stock market betas are in line with the existing REIT literature. The systematic market risk of sampled firms ranges from 0.42 in France to 0.92 in Hong Kong. In all markets, these market risk loadings are below one, indicating a relatively low risk position for listed REITs within the broader financial markets. The interest rate betas for changes in 10-year government yields are reported in Panel B of Table 3. Most median long-term interest rate betas are negative, indicating that listed real estate returns decrease when bond yields increase. However, the magnitude of this inverse relationship varies substantially across the sampled countries. For example, the interest rate exposure is strongest for Japanese REITs.

Market- and interest rate beta's for the U.S. are plotted in Figures 1 and 2. The distribution of market betas for each year within our sample period are plotted in Figure 1. We find an upward sloping trend in systematic market risk as the mean market beta increased from approximately zero in 2000 to just over one in 2008. After the Great Financial Crisis (GFC), market betas trended downward toward the sample average of approximately 0.70. A similar trend is documented for the distribution of the annual market betas. This distribution was fairly tight at the start of the sample, widened substantially during the GFC, and decreased afterwards.

Box plots for 10-year interest rate betas for the U.S. are presented in Figure 2. The distributions within each year tend to be much wider than the market betas, with estimated interest rate betas ranging from less than -20 to more than +20. Although wide, these distributions are rather similar across years. In other words, interest rate betas are less time dependent. However, mean interest rate betas are quite volatile, starting with positive means in the early years, dropping sharply around 2004, bouncing back to positives just before the GFC, and finally dropping back to below the long term negative average.

It appears whenever credit is constrained and interest rates are higher than average the distribution of interest rate betas widens and the mean value drops below zero. That is, debt exposure is harmful for public real estate returns. This is observed in Figure 2, both during the interest rate increase in 2004, and right after the start of the global financial crisis in 2008. We focus the remainder of our analysis on explaining the cross-sectional variation in estimated betas. By linking a wide set of firm characteristics to their interest rate betas, we learn more about the defining factors behind interest rate sensitivity.

4.2 Sorting interest rate risk exposure

Up to this point, we established the facts that interest rate beta's are significant, and that that differ across firm and vary over time. Before we continue our analysis with the identification of the key factors behind these interest rate beta variations across firms, we first examine whether the observed interest rate risk loadings are priced by the market. In other words, does it payoff to know these interest betas from an investors point of view? Is this interest rate risk loading leading subsequent return patterns? We answer these questions by sorting the firms in our sample into quintiles each year based on their estimated interest rate betas. We then compute the average subsequent returns of these portfolios for four time horizons: one, six, 12, a nd 36 months. The difference between the high (1) beta quintile and low beta quintile (5) are calculated for each week in our sample period and are plotted in Figure 3.

This figure tells an interesting story. First, when focusing on the 12 month return difference (the green line) between the highest and lowest interest rate beta returns, we find a positive return in the years leading up the credit crisis. Negative return spreads only occur when credit is tight, indicating that during these periods high interest rate risk exposure decreases public real estate returns. When comparing these 12 month return results with the shorter buy-and-hold returns we find similar, yet weaker, results. Obviously, measuring and comparing shorter term returns will end up in smaller numbers and variations, which explains the difference in level of returns. On the other, we should account for the horizon relevance of interest rate exposure, as our measures change a lot from year to year (see figure 3).

We also aggregate these quintile portfolio returns for our sorting analysis in Table 4. Here, we list the returns, market betas, and interest rate betas for each portfolio, aggregated across all countries over the full sample period. Average portfolio returns increases with interest rate betas. The difference between the two extremes (high minus low) averages 3.47% a year, which is both economically and statistically significant. The variation in market betas shows a comparable transition across quintiles portfolios with the highest market risk tend to have the strongest interest rate betas.

4.3. Explaining interest rate risk exposure

In the final step of our analysis, we focus on the firm specific characteristics that help to explain cross-sectional variation in interest rate betas. This we do by means of a simple multivariate regression analysis in which we relate individual interest rate betas for each firm and for each available week in our sample to firm characteristics.

Table 5 presents the results of weighted least-squares estimates in which we relate firm specific interest rate beta's to: occupancy rates, the share of floating rate debt, the debt ratio, the fraction of short term debt, and the overall debt maturity. Our results can only be compared to Allen et al. (2000) as they performed a similar analysis, yet on a smaller set of explanatory variables. The only common variable, the debt ratio yields conflicting results. In our case, we find and report a positive and significant result, indicating that higher leverage reduces the interest rate risk. Allen et al. (2000) found no significant effect, but this is probably due to their sample size limitations. In our case, this surprising results could be accounted for by the fact that we include leverage both in size (the debt ratio) and structure (the fraction of floating and short term debt). These debt structure variables yield results are in line with expectations. We find positive effects for both, which means that larger fractions of floating and short-term debt increase the interest rate beta of listed real estate returns. These results are intuitive, as floating rate debt directly introduces the swings of the interest rate into the cash flow structure of the firm, and short term debt increases the corporate exposure to interest rate changes as shorter term debt immediate the refinancing of debt conditions. The combined results that debt levels do not appear to matter here, while debt structure does, may well be seen as an indicator that the link between corporate capital structure and interest rate exposure is less straightforward then assumed.

Increased occupancy rates of the real estate portfolio reduce interest rate betas, a result that can be explained by the fact that higher occupancy reduces the relative importance of debt payments with the corporate cash flow diagram. Finally, regarding overall corporate debt maturity, our results vary across model specifications. In the most simply estimation, we report positive and significant results, which are counter intuitive, as we expect long maturity debt to shield of the exposure to refinancing impact. However, these positive estimates become insignificant once we include country fixed effects and cluster the standard errors.

Overall, we can conclude that the most reliable model estimates yield proof that two firm characteristics matter when comparing interest rate sensitivity. The occupancy rate of the real estate portfolio, which dampens the importance of interest rate expenses in the cash flow of the firm and thereby reduce the interest rate sensitivity. The share of short term debt. More than the total level of corporate debt, investors should look out for listed real estate firms with small fractions of short term debt, when they seek ways to reduce the interest rate sensitivity when listed real estate firms into their investment portfolio.

5. Conclusions and Implications

We analyze the interest-rate sensitivity of international public real estate firms at a time when institutional investors are confronted with low coverage ratios and the prospect of an increase of the current historical low in interest rates. At times, when returns are low or uncertain, interest rate movements matter more. For fixed income assets, duration is typically used to assess the interest rate exposure of investments. For public real estate investments, no conclusive evidence is available that explains the relevance and variation in interest rate sensitivity on an individual firm level.

In this paper, we provide empirical evidence regarding the interlink between public real estate return and interest rate dynamics, for 723 REITs in 10 markets for the period 1999-2015. Our analysis consists of three stages. First, we analyzed the interest rate risk loading of individual REITs using a standard two factor asset pricing model. The resulting interest rate beta’s differed widely across firm and changed gradually over our sample period. Overall, it seems that interest rate loadings increase when credit is tight and more expensive. We continued our analysis with sorting our sampled REITs into decile portfolio based on their interest rate beta’s and documented a return premium of 3.47% a year across the high versus low risk portfolios. This shows, that interest rate risk does not only differ across firm, but that it also leads to a variation in return. Interest rate beta’s are priced, but at a premium that changes over time. The highest premiums are, again, reported during the periods when credit was less abundant. Finally, we also examined the firm characteristics of REITs that may help to explain the observed variation in the firm level interest rate beta’s. Our empirical results confirm what the available literature indicated before. We find that interest rate sensitivity is stronger for firms with large fractions of short debt maturities and low occupancy rates in their property portfolios. Results that are in line with the cash flow concept of duration, since shorter term debt enhance the exposure of a firm to the swings of interest rates.

The implication of these results are relevant for a wide audience. For public real estate firm management, our results indicate that capital structure management gains relevance, since subsequent stock returns are related to how (and how much) firms are levered. For investors, our results show that it is important and relevant to include the details of interest rate sensitivity into their due diligence process, as a premium can be earned and lost due to the ex-post exposure to interest-rate risks. Finally, our results also have implication for the academic literature as we provide evidence that shows that research on interest rate risk for non-fixed income investments is needed. Also beyond the concept of duration, new metrics may well be needed to capture and examine why interest rate risk differs across firms and over time. More research is needed to disentangle this interest rate impact on stock returns and to design metrics that succeed in capturing price relevant interest rate risk ex-ante.

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Table 1 - Summary Statistics for total returns from weekly data: 1995-2015

Country	# Comp	Average Return	Std. Dev. Return	# Records	Start Date
Australia	43	15.34	37.14	24,556	1995-06
Canada	76	10.46	42.80	22,031	2006-06
France	17	15.28	33.92	11,359	1999-01
Germany	11	18.06	39.96	4,016	1997-07
Hong Kong	79	7.24	42.71	22,242	2010-01
Japan	59	13.29	43.90	33,179	1995-06
Singapore	44	12.50	39.97	23,478	1999-01
Sweden	19	19.42	37.24	8,966	2002-06
UK	76	11.68	34.40	37,572	1995-06
US	299	15.34	36.44	168,389	1995-06

This table presents descriptive statistics for 293,870 company-week records. The average return is the average annualized weekly firm total return, expressed as percentages and obtained from Factset. The Std. Dev. Return column is the annualized standard deviation of the weekly returns. Returns are annualized by multiplying the mean weekly return by 52 and the annualized standard deviation is calculated by multiplying the weekly standard deviation by the square root of 52. The number of records is the total number of company-week observations per country. The start date is the first week for which we have data for that country. Over half of all observations are from US companies. Only records are taken into account for which a weekly company return, the return of its local corresponding market index and the change in its local corresponding government bond yield are available. These data we need to determine the companies interest rate beta in a certain year.

Table 2 - Summary Statistics for effective government bond rates

Country	Avg Rate	Std.Dev. Rate	Avg RF	Std.Dev. RF
Australia	5.49	1.36	4.92	1.39
Canada	2.92	0.89	1.73	1.37
France	3.65	1.17	2.17	1.37
Germany	3.35	1.35	2.14	1.39
Hong Kong	1.98	0.58	0.20	0.02
Japan	1.37	0.67	0.24	0.23
Singapore	2.90	0.87	1.09	1.02
Sweden	3.15	1.20	1.95	1.33
UK	4.70	1.34	3.70	2.39
US	4.20	1.42	2.71	2.34

We obtained weekly observations of the annual effective rates on long maturity government bond indices per country from the countries website of the national bank. For Australia, Canada, the U.S., Singapore, Hong Kong and Sweden we used the 10yr government bond index, for Japan the 9yr government bond index and for the U.K. the 20yr government bond index.
The average rate is the average from the weekly observations of the annual rate. The standard deviation is the annual standard deviation of these annual rates. The risk free rate is the Central Bank's annual policy rate as obtained from the IMF with a weekly frequency. We average the weekly observations of the annual policy rate.
The annual market and interest betas are derived from estimating a two factor model with weekly data per firm per year: $R_{it} - RF_{t,c} = \beta_{iy} + \beta_{iy}^{mkt} * (R_{mkt,t,c} - RF_{t,c}) + \beta_{iy}^{interest} * Ortho(\Delta IRATE_{t,c}) + \mu_{iy}$ where: R_{it} is the total return in week t of firm I; $RF_{t,c}$ is the weekly risk free rate in week t for firms home country c; $R_{it} - RF_{t,c}$ is the excess return of firm i in week t; β_{iy} is a constant for the regression of firm i in year y; β_{iy}^{mkt} is the sensitivity of firm i's weekly excess return to excess returns of the market index; $R_{mkt,t,c}$ is the total return of the market index of firm i's home country c in week t; $R_{mkt,t,c} - RF_{t,c}$ is the excess market return in country c over week t; $\beta_{iy}^{interest}$is the sensitivity of the firm i's weekly return to the orthogonalized change in effective long term government bond rates; μ_{iy} is the standard error term of the regression for firm I in year y. The orthogonalisation regression that is estimated per country is: $\Delta IRATE_{t,c} = \gamma_c + \gamma_c^{mkt} * (R_{mkt,t,c} - RF_{t,c}) + Ortho(\Delta IRATE_{t,c})$ where $\Delta IRATE_{t,c}$is the weekly change in the effective rate of the long term government bond index of country c; $\gamma_c$is a constant for the orthogonalisation regression of country c; $\gamma_c^{mkt}$is the sensitivity of the weekly change in long term government bond rates to the return of the market index of country c; $Ortho(\Delta IRATE_{t,c})$ is the weekly residual of the orthogonalisation regression used as input for the interest change in the first stage regression used to estimate the market and interest betas

Table 3 - Interest rate betas and market betas per country

Panel A, Significance and distribution of market betas

	Obs	Mean beta	Std.Dev	Median	Pos and sig*	Neg and sig*
Australia	524	0.57	0.58	0.56	0.70	0.01
Canada	497	0.69	0.65	0.54	0.67	0.002
France	237	0.42	0.40	0.34	0.62	0.02
Germany	86	0.58	0.33	0.59	0.84	0.01
Hong Kong	469	0.92	0.50	0.92	0.90	0.00
Japan	693	0.73	0.49	0.62	0.83	0.003
Singapore	499	0.76	0.50	0.72	0.82	0.004
Sweden	190	0.62	0.42	0.64	0.83	0.01
UK	853	0.56	0.48	0.54	0.70	0.01
US	3,540	0.65	0.59	0.60	0.70	0.01

Panel B, Significance and distribution of interest betas

	Obs	Mean beta	Std.Dev	Median	Pos and sig*	Neg and sig*
Australia	524	-0.38	6.32	-0.92	0.06	0.17
Canada	497	0.42	11.15	-1.00	0.11	0.17
France	237	-0.64	7.04	-1.45	0.07	0.17
Germany	86	0.08	8.61	-0.83	0.07	0.09
Hong Kong	469	1.83	8.78	1.22	0.13	0.07
Japan	693	-4.39	16.58	-3.51	0.08	0.17
Singapore	499	0.03	8.81	-1.18	0.10	0.16
Sweden	190	-1.30	10.33	-1.78	0.07	0.17
UK	853	-1.08	7.51	-1.04	0.08	0.12
US	3,540	-1.75	6.81	-1.63	0.07	0.26

*= Significance at the 10 percent level

The sample runs from January 1995 to December 2015. The annual market and interest betas are derived from estimating a two factor model with weekly data per firm per year with a minimum of 10 weekly observation in a year. $R_{it} - RF_{t,c} = \beta_{iy} + \beta_{iy}^{mkt} * (R_{mkt,t,c} - RF_{t,c}) + \beta_{iy}^{interest} * Ortho(\Delta IRATE_{t,c}) + \mu_{iy}$ where: R_{it} is the total return in week t of firm I; $RF_{t,c}$ is the weekly risk free rate in week t for firms home country c; $R_{it} - RF_{t,c}$ is the excess return of firm i in week t; β_{iy} is a constant for the regression of firm i in year y; β_{iy}^{mkt} is the sensitivity of firm i's weekly excess return to excess returns of the market index; $R_{mkt,t,c}$ is the total return of the market index of firm i's home country c in week t; $R_{mkt,t,c} - RF_{t,c}$ is the excess market return in country c over week t; $\beta_{iy}^{interest}$is the sensitivity of the firm i's weekly return to the orthogonalized change in effective long term government bond rates; μ_{iy} is the standard error term of the regression for firm I in year y. The orthogonalisation regression that is estimated per country is: $\Delta IRATE_{t,c} = \gamma_c + \gamma_c^{mkt} * (R_{mkt,t,c} - RF_{t,c}) + Ortho(\Delta IRATE_{t,c})$ where $\Delta IRATE_{t,c}$is the weekly change in the effective rate of the long term government bond index of country c; $\gamma_c$is a constant for the orthogonalisation regression of country c; $\gamma_c^{mkt}$is the sensitivity of the weekly change in long term government bond rates to the return of the market index of country c; $Ortho(\Delta IRATE_{t,c})$ is the weekly residual of the orthogonalisation regression used as input for the interest change in the first stage regression used to estimate the market and interest betas presented in table 3a and 3b. The observations are the counts of the annual betas per country; the positive and negative significant interest and market betas is the percentage of betas that are at least significant at the 10% level.

Figure 1 – Plot of time varying market beta distributions for the whole sample

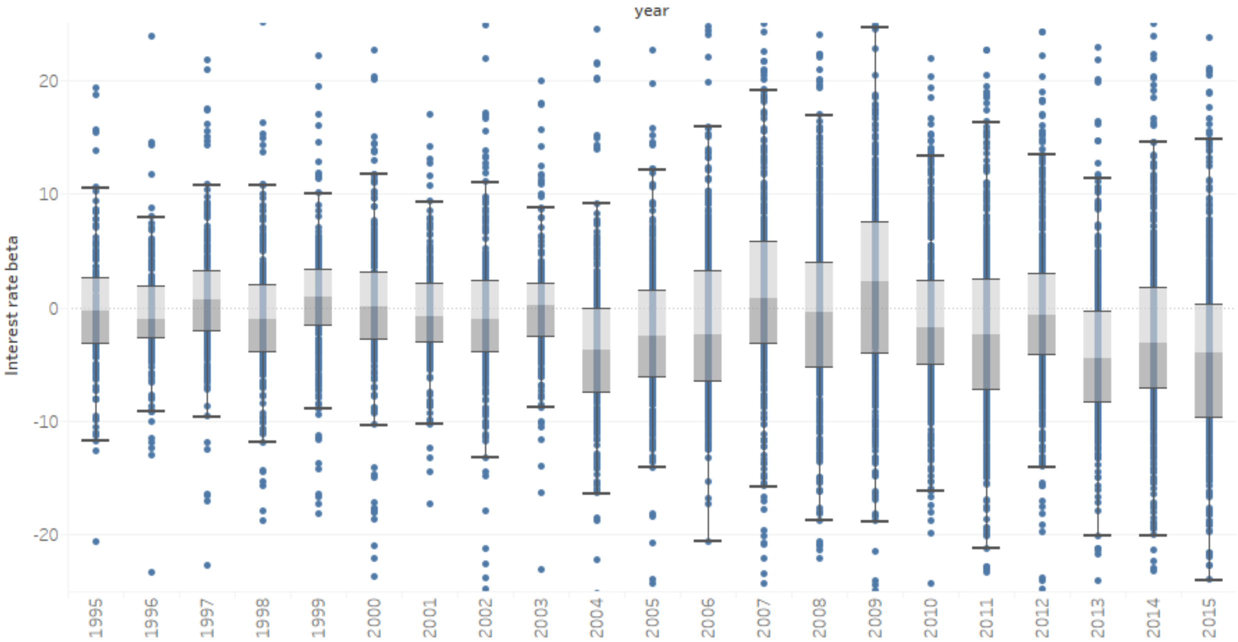


Figure one displays the dispersion of annual market betas per year for the U.S.. The market betas are estimated with the two factor first stage regression. On average we estimated 151 betas for U.S. firms per annum. The bottom of the box is the 1st quartile of the beta distribution in that year while the top of the box is the third quartile. The 2nd quartile is characterized by the border of the light and dark grey area. The upper and lower bar are 1.5 times the inter quartile range. The dots represent individual firm betas in that year and show whether there are outliers. The annual market betas are derived from estimating a two factor model with weekly data per firm per year with a minimum of 10 weekly observation in a year. $R_{it} - RF_{t,c} = \beta_{iy} + \beta_{iy}^{mkt} * (R_{mkt,t,c} - RF_{t,c}) + \beta_{iy}^{interest} * Ortho(\Delta IRATE_{t,c}) + \mu_{iy}$ where: R_{it} is the total return in week t of firm I; $RF_{t,c}$ is the weekly risk free rate in week t for firms home country c; $R_{it} - RF_{t,c}$ is the excess return of firm i in week t; β_{iy} is a constant for the regression of firm i in year y; β_{iy}^{mkt} is the sensitivity of firm i's weekly excess return to excess returns of the market index; $R_{mkt,t,c}$ is the total return of the market index of firm i's home country c in week t; $R_{mkt,t,c} - RF_{t,c}$ is the excess market return in country c over week t; $\beta_{iy}^{interest}$ is the sensitivity of the firm i's weekly return to the orthogonalized change in effective long term government bond rates; μ_{iy} is the standard error term of the regression for firm I in year y.

Figure 2 – Plot of time varying interest rate beta distributions for the whole sample

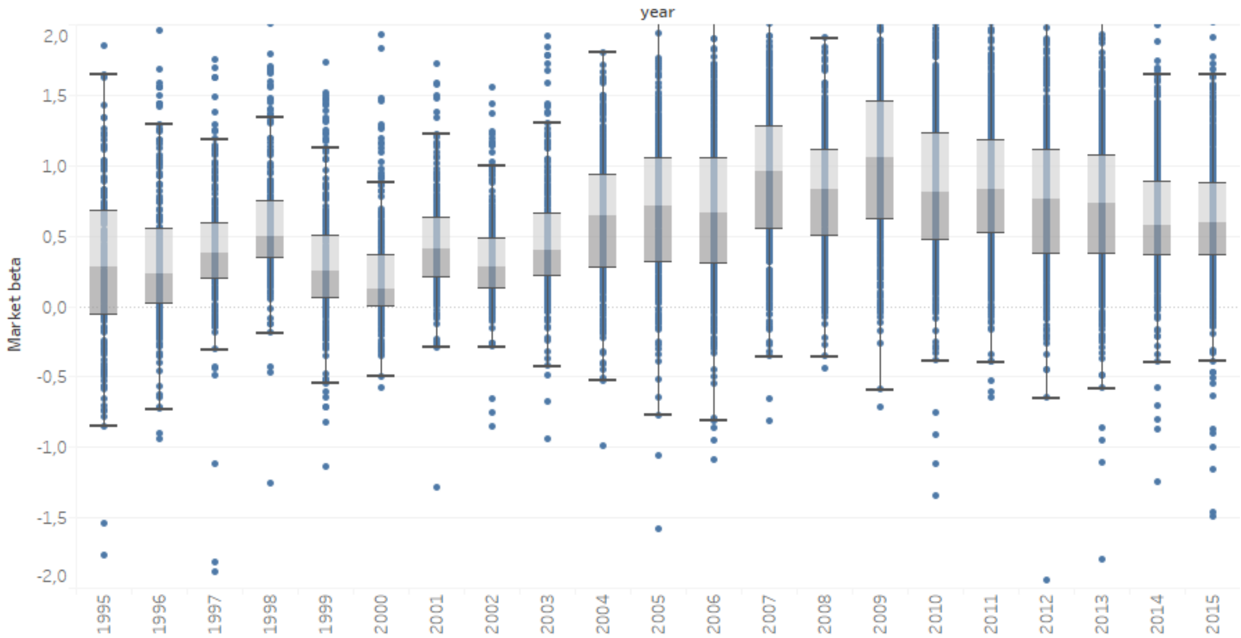


Figure two displays the dispersion of annual interest rate betas per year for the U.S.. The interest rate betas are estimated with the two factor first stage regression. On average we estimated 151 betas for U.S. firms per annum. The bottom of the box is the 1st quartile of the beta distribution in that year while the top of the box is the third quartile. The 2nd quartile is characterized by the border of the light and dark grey area. The upper and lower bar are 1.5 times the inter quartile range. The dots represent individual firm betas in that year and show whether there are outliers. The annual interest rate betas are derived from estimating a two factor model with weekly data per firm per year with a minimum of 10 weekly observation in a year. $R_{it} - RF_{t,c} = \beta_{iy} + \beta_{iy}^{mkt} * (R_{mkt,t,c} - RF_{t,c}) + \beta_{iy}^{interest} * Ortho(\Delta IRATE_{t,c}) + \mu_{iy}$ where: R_{it} is the total return in week t of firm I; $RF_{t,c}$ is the weekly risk free rate in week t for firms home country c; $R_{it} - RF_{t,c}$ is the excess return of firm i in week t; β_{iy} is a constant for the regression of firm i in year y; β_{iy}^{mkt} is the sensitivity of firm i's weekly excess return to excess returns of the market index; $R_{mkt,t,c}$ is the total return of the market index of firm i's home country c in week t; $R_{mkt,t,c} - RF_{t,c}$ is the excess market return in country c over week t; $\beta_{iy}^{interest}$ is the sensitivity of the firm i's weekly return to the orthogonalized change in effective long term government bond rates; μ_{iy} is the standard error term of the regression for firm I in year y.

Table 4 – Interest Rate Beta Sorted Portfolios

Panel A, Equally weighted returns per Interest rate beta sort

	low	2	3	4	high	spread: high-low	t-statistic
One month	2.53	1.72	1.46	1.40	2.42	-0.11	-0.08
Six month	8.10	7.65	8.40	9.38	12.22	4.12	1.34
Twelve month	13.04	14.38	14.08	15.48	16.51	3.47	0.44
Three year	48.10	43.23	42.68	45.34	50.31	2.21	0.12

Panel B, Value weighted returns per Interest rate beta sort

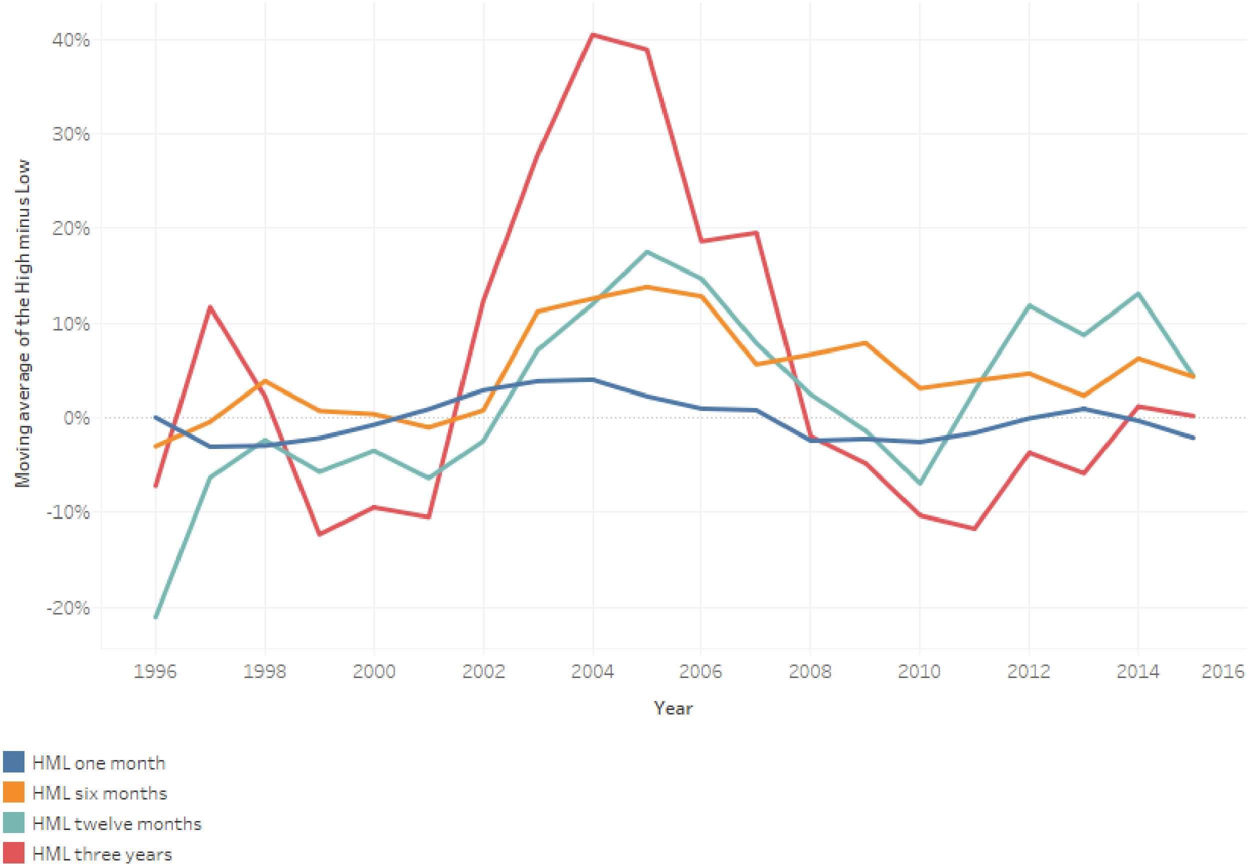
	low	2	3	4	high	spread: high-low	t-statistic
One month	2.24	1.13	0.52	0.23	1.90	-0.34	-0.22
Six month	3.95	7.02	6.38	7.06	9.24	5.29	1.46
Twelve month	7.63	9.84	11.51	10.01	9.04	1.41	0.18
Three year	29.81	26.36	31.82	29.68	31.02	1.21	0.07

Panel C, Firm characteristics per Interest rate beta sort

	low	2	3	4	high	spread: high-low	t-statistic
Avg mcap	1,787	1,776	1,550	1,409	1,313	-474	-1.54
Avg m-beta	0.61	0.62	0.58	0.60	0.68	0.08	0.88

At the start of each year the firms are grouped into quintile portfolios based on the interest rate beta. For each portfolio we calculate the one, six, twelve and thirty-six month forward total portfolio return per year. Panel A displays the averages of the equally weighted annual portfolio forward returns, the spread indicates the average difference of the forward returns of the high interest rate beta portfolio and the low interest rate beta portfolio. The t-statistic indicates whether the difference between the high and low interest rate beta portfolios are close to zero. Panel B displays the value weighted annual portfolio forward returns and their spread and t-statistic. Panel C indicates the average market capitalization denominated in euros per interest rate beta quintile and the average market beta as estimated in the first stage regression.

Figure 3 – HML (1, 6, 12 and 36 month) return spreads over time



Each year we estimate per firm an interest rate beta. At the beginning of the next year we group our sample into quintile portfolios based on this interest rate beta. Per quintile portfolio we calculate the equally weighted average 1 month, 6 month, 12 month and 36 month forward total firm return. Per year we determine the 1,6,12 and 36 month forward return difference between the high interest rate beta quintile portfolio and the low interest rate beta portfolio. Figure three shows the development of these differences over time.. We have smoothed the lines by taking the 3yr rolling averages of the return differences. The blue line is the HML one month, the difference of the one month forward equally weighted average portfolio returns of the high minus the low interest rate beta portfolios. The orange line is for the six month forward return differences, the turquoise line for the 12 months difference and the red one for the 36 month differences.

Table 5 – multivariate REIT regression to explain cross section in interest rate beta's

	Dependent variable:			
	Interest rate beta			
	plain	Incl.weights	Incl. fe	Incl. clust. se
	(1)	(2)	(3)	(4)
Occupancy (%)	-0.013	-0.030	-0.075*	-0.075*
Expected: -	(0.036)	(0.042)	(0.040)	(0.041)
Variable debt (%)	0.023	0.036*	-0.011	-0.011
Expected: +	(0.019)	(0.019)	(0.013)	(0.016)
Loan to value (%)	11.899***	4.509***	1.040	1.040
Expected: -	(1.688)	(1.731)	(1.425)	(1.738)
Short term debt (%)	-0.013	0.038**	0.050***	0.050***
Expected: +	(0.021)	(0.019)	(0.018)	(0.015)
Maturity debt (mths)	0.027***	0.030***	-0.009	-0.009
Expected: -	(0.009)	(0.008)	(0.006)	(0.006)
Constant	-11.107***	-6.094		
	(3.598)	(3.946)		
Observations	524	524	501	501
R2	0.104	0.050	0.657	0.657
Adjusted R2	0.096	0.040	0.635	0.635
Residual Std. Error	5.6(df=518)	1.6(df=518)	0.9(df=471)	0.9(df=471)

Note:*p<0.1; **p<0.05; ***p<0.01

The sample runs from January 1995 to December 2015. The dependent variables are the annual interest rate betas from the two factor models. The estimates are based on pooled time series cross sectional weighted least square regressions. The weights of the regression are proportional to the standard errors of the interest rate betas of the first stage regression. We include year and sector fixed effects where we obtained the sector from SNL financial being the main sector of the company. The standard errors are clustered per firm. The second stage regression specification is:

$$\beta_{iy}^{interest} = \emptyset_0 + \emptyset_1 * Occ_{i,y-1} + \emptyset_2 * VarDebt_{i,y-1} + \emptyset_3 * LtV_{i,y-1} + \emptyset_4 * StDebt_{i,y-1} + \emptyset_5 * MatDebt_{i,y-1} + \varepsilon$$

where $\beta_{iy}^{interest}$ is the sensitivity of firm i in year y to changes in the interest rate as estimated in the first stage regression; $\emptyset_0$ is a constant; $\emptyset_1$ is the sensitivity of the interest rate beta to the occupancy rate; Occ_{y-1} is the occupancy rate at the end of the previous year obtained from SNL financial; $\emptyset_2$ is the sensitivity to the percentage of variable debt of the interest rate beta of firm i; $VarDebt_{y-1}$ is the percentage of the variable debt at the end of y-1 obtained from SNL financial; $\emptyset_3$ is the sensitivity to the Loan to Value; LtV_{y-1} is the Loan to Value at the end of the previous year, calculated as the firms total liabilities obtained from SNL financial divided by the sum of the total liabilities and the market capitalization obtained from Factset; $\emptyset_4$ is the sensitivity to the short term debt; $StDebt_{y-1}$ is the percentage of debt of firm i maturing within 2 years as obtained from SNL financial; $\emptyset_5$ is the sensitivity of the interest rate beta to the maturity of the firms debt; $MatDebt_{i,y-1}$ is the maturity in months of firm I, obtained from SNL financial; ε is the standard error term.