The Beta Anomaly in the REIT Market

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Abstract:

This research examined whether the beta anomaly exists in the REIT market. By analysing a low-minus-high beta strategy and a betting-against-beta strategy in the REIT market, we find that high-beta REITs earn significantly lower risk-adjusted returns than low-beta REITs. This beta anomaly is only significant in the New REIT Era after 1993. The negative relationship between beta and REIT stock return does not disappear after taking into account some firm characteristics, suggesting that the beta anomaly in the REIT market is not driven by beta's correlation with profitability, asset growth, lottery-like return or the skewness of stock returns. We find that institutional investors, whose portfolios increasingly contain a significant proportion of REITs, prefer the high-beta REITs. The exposure of institutional investors to high-beta REITs could explain the beta anomaly in the REIT market.

Keywords: beta anomaly; leverage constraints; institutional ownership; New REIT Era

The Beta Anomaly in the REIT Market

Introduction

The effectiveness of the Capital Asset Pricing Model (CAPM) (Sharpe, 1964; Lintner, 1965; Mossin, 1966) has been challenged by empirical studies for a long time. Black, Jensen, and Scholes (1972) show that the security market line is flatter than the CAPM implies, i.e., high-beta stocks earn relatively lower risk-adjusted returns than low-beta stocks. The underperformance of high-beta assets relative to low-beta assets is well-known as the beta anomaly. The beta anomaly has received considerable attention because it challenges the classic CAPM and is prevalent in the US equity market (Friend and Blume, 1970), international equity markets (Walkshäusl, 2014; Han, Li and Li, 2019), bond markets and futures market (Frazzini and Pedersen, 2014). The negative relationship between beta and stock returns, however, has not yet been investigated in the REIT market.

REITs have unique features that provide many conditions favourable to investigation of the existence of the beta anomaly in a unique asset market and the cause of the beta anomaly. Early studies tended to regard REITs as bond-like assets because of their stable and predictable income, and REIT returns were strongly correlated with bond returns before the 1990s (Peterson and Hsieh, 1997; Karolyi and Sanders, 1998). REITs turned into more stock-like asset (Glascock, Lu and So, 2000) and REIT returns became highly related to the small-cap stock returns following the structural REIT market changes in the early 1990s (Clayton and MacKinnon, 2001, 2003).[1] The unique features and fundamental changes in the REIT market provides a good chance to observe whether classic CAPM is also challenged in the REIT market and whether the anomaly related to REIT beta exists in the market. Accompanying the structural changes is an increase in institutional REIT ownerships (Lee and Lee, 2003; Devos et al., 2013; Shen, 2020).[2] The change in institutional investments also allows the test of a leverage constraints hypothesis (Black, 1972) and the argument that institutional investors, such as mutual funds, push up the price of high-beta stocks and cause the beta anomaly (Frazzini and Pedersen, 2014; Christoffersen and Simutin, 2017).

Using a sample of equity REITs listed in the US between 1982 and 2017, beta-sorted portfolios were constructed in this study to check for the beta anomaly in the REIT market. Consistent

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[1] Some studies also show that REIT returns are also link to a real estate factor (Clayton and MacKinnon, 2001; Boudry et al., 2011). REITs could also behave like real estate assets.

[2] Clayton and MacKinnon (2003) argue that the institutionalization of REIT ownership can explain the dynamic relationships between REITs returns, stock/bond market return, and real estate returns.

with the findings for the general stock market (e.g., Bali et al., 2017), the high-beta REITs give lower risk-adjusted returns than the low-beta REITs. Specifically, the equal-weighted portfolio of long low-beta REITs and short high-beta REITs yields a significant alpha, from the Fama-French three-factor model, by 0.368% per month. The value-weighted portfolio earns even higher abnormal returns and the alphas from CAPM, the Fama-French three-factor model and the Van Nieuwerburgh five-factor model (Van Nieuwerburgh, 2019) are 0.354%, 0.508% and 0.622% per month respectively. The abnormal returns for a betting-against-beta strategy, as proposed in Frazzini and Pedersen (2014) to exploit the beta anomaly, are also significantly positive. In sum, the beta anomaly is documented in the REIT market as both a simple low-minus-high beta strategy and a betting-against-beta strategy.

We further analysed the beta anomaly for the Vintage REIT Era (1982-1993) and the New REIT Era (1994-2017) separately. Previous studies argue that the vintage REIT is more of a bond-like asset and beta cannot explain the variations in REIT returns before the 1990s (Glascock, Lu and So, 2000; Chen, Hsieh, Vines and Chiou, 1998). Consistently, we found that the beta anomaly is not significant in the Vintage REIT Era. The beta anomaly becomes significant in the New REIT Era when REITs become stock-like securities and beta can better capture the co-movement between REIT return and market portfolio return.

A cross-sectional regression analysis showed that the negative relationship between beta and REIT return still holds, after controlling for REIT market capitalization, book-to-market ratio and past stock return. The results confirm again that the beta-REIT return relationship is only significant in the New REIT Era. Some studies argue that the beta anomaly in the general stock market is driven by the beta's correlation with some firm characteristics, such as profitability and investment (Novy-Marx and Velikov, 2018), lottery-like return (Bali et al., 2017) and the skewness of stock returns (Schneider, Wagner and Zechner, 2020); and that the beta anomaly should disappear after controlling for these characteristics. However, we found that the negative relationship between beta and REIT return remains significant even after taking these characteristics into account.

Lastly, this research shows that the beta anomaly in the REIT market could be caused by the preference of institutional investors for high-beta REITs. The leverage constraints hypothesis (Black 1972) argues that to beat the market benchmark, investors with leverage constraints, such as mutual funds, increase their exposure to high-beta stocks and reduce holdings of low-beta stocks, causing higher prices and low risk-adjusted returns in the high-beta stocks

(Frazzini and Pedersen, 2014; Christoffersen and Simutin, 2017). This study shows that institutional ownership in REITs is positively associated with REIT beta after taking the different motives of institutional investors into account, indicating that institutional investors have preference for high-beta REITs. The institutional investment in high-beta REITs could be due to the efforts of institutional investors to overweight riskier assets and beat the market, leading to higher price high-beta REITs and the beta anomaly in the REIT market. Consistent with the existence of the beta anomaly in only the New REIT Era, we showed that the positive relationship between institutional ownership and beta is indeed significant only in the New REIT Era.

This research mainly contributes to the asset pricing literature of REITs. Although the beta anomaly is one of the most persistent stock return anomalies (Black, Jensen, and Scholes, 1972), it has not been examined in the case of the real estate market. This paper is the first to document the beta anomaly in the REIT market and show that the beta anomaly appeared only after structural changes occurred in the REITs market. It also sheds light on the cause of the beta anomaly based on the unique features of the REIT market. The study adds evidence to support the leverage constraints hypothesis in explaining the beta anomaly, but rejects the arguments that beta anomaly is driven by the beta correlation with some specific characteristics of the firms concerned.

The paper is structured as follows. The literature review and hypothesis development are presented in the next section. Data and variables are described in the third section. The fourth section, which presents the empirical results, is followed by a Concluding section.

Literature Review and Hypothesis development

The Capital Asset Pricing Model (CAPM) (Sharpe, 1964; Lintner, 1965; Mossin, 1966) suggests that the higher systematic risk (beta) should be compensated by higher expected returns, which implies that the security market line should be steep. However, empirical studies document that the security market line is flatter (and even a reverse slope) than is implied by CAPM: the high-beta assets earn lower risk-adjusted returns than low-beta assets (Friend and Blume, 1970; Black, Jensen, and Scholes, 1972). This negative relationship between beta and future stock returns is well-known as the beta anomaly. The negative relationship remains even after controlling asset pricing factors such as size and value (Fama and French, 1992, 2006) and is also confirmed in the international market (Walkshäusl, 2014).[3] However, the beta anomaly has not yet been examined in the REIT market.

There is a long on-going debate on whether a REIT is a bond or a stock. On the one hand, like common stocks, REITs are traded on the stock exchange market; and on the other hand, similar to fixed-income assets, REITs provide stable and predictable cash flows to investors as REITs are required to distribute at least 90% of their earnings as dividends to investors. Early studies found returns on REITs to be positively associated with fixed-income assets (Peterson and Hsieh, 1997; Karolyi and Sanders, 1998; Clayton and Mackinnon, 2001). The correlation between bond returns and REIT returns was stronger before the 1990s (Glascock, Lu and So, 2000; Clayton and Mackinnon, 2003), and the stock beta cannot explain the cross-sectional returns of REITs (Chen, Hsieh, Vines and Chiou, 1998). Later studies argue that REITs became stock-like assets following the structural changes in the REIT market in the early 1990s (Glascock, Lu and So, 2000), and that REITs behave like small-cap stocks (Clayton and MacKinnon, 2001, 2003; Nelling and Gyourko, 1998; Chiang and Lee, 2002). The mixed features of REITs and fundamental changes in the REIT market provide a good chance to explore the existence of the beta anomaly in relation to securitized real estate assets.[4]

We argued that the beta anomaly, that is the abnormal return from long low-beta REITs and short high-beta REITs, also exists in the REIT market. This anomaly should be more robust when REITs behaved more like stocks after the structural change in the early 1990s. Following previous studies (Cakici, Erol and Tirtiroglu, 2014; Shen, 2020), we explored the beta anomaly separately in the Vintage REIT Era and the New REIT Era adopting the cut-off year 1993.[5] As REITs behaved more like bonds in the Vintage REIT Era, stock returns on REITs were not strongly related to overall stock market returns or determined by REIT betas (Chen, Hsieh, Vines and Chiou, 1998). However, after the fundamental changes that turned REITs to stock-

[3] A recent study by Frazzini and Pedersen (2014) proposes a market-neutral betting-against-beta (BAB) strategy which exploits the beta anomaly by buying a portfolio of low-beta assets (and leveraging to a beta of one) and shorting a portfolio of high-beta ones (and deleveraging to a beta of one). The BAB strategy, which has zero exposure to beta, earns significant positive returns even after controlling the Fama-French three factors (1993), Carhart's momentum factor (1997) and Pástor and Stambaugh (2003) liquidity factor. This BAB strategy is essentially a mean to exploit the beta anomaly (Bali, Brown, Murray and Tang, 2017).

[4] Frazzini and Pedersen (2014) document that beta anomaly exists in equities, Treasury bonds, corporate bonds and futures. The beta anomaly in the alternative asset markets such as real estate has not been investigated.

[5] There were several key changes in the REIT market in the early 1990s, including the creation of UPREIT structure, the great flexibility in institutional holding of REITs, the shift from "externally advised" to "internally advised" in the organizational structure, etc. (Ambrose and Linneman, 1998, 2001; Chan, Leung and Wang, 1998)

like assets, it is expected to find the beta anomaly exists in the REIT market. Our first hypothesis is given as:

H1: The beta anomaly exists in the REIT market.

H1a: The beta anomaly only exists in the REIT market in the New REIT Era.

There are many competing explanations of the beta anomaly in the literature. Some studies argue that the beta anomaly could be attributed to other stock anomalies documented in the stock market and investor preferences over some specific types of stocks.[6] Novy-Marx (2016) shows that most high-beta stocks are small and unprofitable firms with high market-to-book ratios. He argues that the beta anomaly is caused by the underperformance of these stocks. Schneider, Wagner and Zechner (2020) show that the beta anomaly results from investor requirement for compensation for co-skewness risk and becomes insignificant after controlling for the skewness of stock return.[7] Bali, Brown, Murray and Tang (2017) assert that the beta anomaly can be explained by "lottery demand" of some investors. The preferences for stocks with large probabilities of short-term gains push up the prices of these stocks and cause lower subsequent returns. These stocks are also highly likely to be high-beta stock. They show that after considering the lottery-demand factor, the beta anomaly disappears. In other words, these studies argue that the beta anomaly is driven by the beta's correlation with some firm characteristics. If the beta anomaly in the REIT market were also caused by such firm characteristics, identified in the general stock market, the anomaly would disappear after they have been taken into account.[8] The second hypothesis is given as:

H2: The negative relationship between beta and REIT stock return disappears after taking profitability, lottery-like return and co-skewness risk of stock returns into account.

Alternatively, the leverage constraints hypothesis (Black, 1972) argues that investors with leverage constraints, such as mutual funds, would overweight high-beta assets to achieve a high return, which in turn pushes up the price of high-beta assets and results in a lower risk-adjusted return in these assets. Frazzini and Pedersen (2014) tested the leverage constraints hypothesis

[6] This stream of studies is related to behavioural finance literature. On the contrary, leverage constraints hypothesis is a rational-based explanation for beta anomaly

[7] Skewness captures the third central moment of stock return distribution. It is the covariance of stock return with squared market return. Harvey and Siddique (2000) show that investors require extra premium to accept the coskewness risk.

[8] Some studies have shown that profitability and investment (asset growth) can explain the variations of REIT returns (Bond and Xue, 2017; Ling, Ooi and Xu, 2019). The factors related to lottery demand and skewness risk have not been examined thoroughly in the REIT market.

by examining the asset pricing effect of funding constraint and showed that a strategy to exploit the beta anomaly is more profitable when the funding constraint is tight. Christoffersen and Simutin (2017) found that to outperform a benchmark, fund managers tend to increase the exposure to high-beta stocks and decrease the holdings of low-beta stocks. The over-demand for high-beta stocks by mutual funds can explain the low risk-adjusted returns of high-beta stocks. The findings of Boguth and Simutin (2018) also support the argument that the tightness of leverage constraints in mutual funds can explain the beta anomaly.

The Omnibus Budget Reconciliation Act of 1993 lessened the ownership restrictions on REITs which qualified for tax advantages, inducing more institutions to include REITs in their portfolios (Chan, Leung and Wang, 1998, 2005).[9] The institutional ownership in REITs increased from less than 10% before 1990 to more than 60% in 2010s (Lee and Lee, 2003; Devos et al., 2013; Shen, 2020). If, following the leverage constraints hypothesis, beta anomaly is caused by the overweighting of high-beta stocks in the portfolios of institutional investors (Christoffersen and Simutin, 2017), we can expect to observe that institutional investors prefer high-beta REITs, other firm characteristics in the REITs being constant.[10] The increase of REIT holdings by institutional investors and their preference for high-beta REITs lead to high stock prices and low risk-adjusted returns in those REITs. It is also expected that the relationship between REIT beta and institutional REIT holdings is only significant in the New REIT Era as (1) beta anomaly may only be robust after REITs become stock-like assets and (2) institutional investors start to heavily invest in RETs in the New REIT Era.

H3: As leverage constrained investors, institutional investors prefer high-beta REITs, if other characteristics are constant.

H3a: The positive relationship between REIT beta and institutional REIT holdings is only significant in the New REIT Era.

[9] The increase in institutional ownership leads to an increase in the correlation between REITs and stocks (Glascock, Lu and So, 2000), increases the returns on externally-advised REITs (Brockman, French and Tamm, 2014), and reduces the unsystematic risk (Crain, Cudd and Brown, 2000). The relationship between institutional ownership and the beta in the REITs has not yet been explored thoroughly. The change of investor base in the REIT market provides a unique chance to test the explanations of beta anomaly.

[10] Gompers and Metrick (2001) argue that the determinants of institutional ownership include prudence considerations, liquidity motives and past returns on the stocks. The prudence considerations suggest that institutional investors are less likely to hold stocks with high firm risk (Del Guercio, 1996; Gompers and Metrick, 2001), indicating a negative relationship between beta and institutional ownership. REIT is considered as an asset that provides diversification benefits to institutional investors. The diversification motive also suggest that institutional investors should prefer low-beta REITs. Thus, a positive relationship between beta and institutional ownership in the REITs could be due to efforts of institutional investors to beat benchmark.

Data, Sample and Variables

We collected all listed US REITs from the CRSP/Ziman database and restricted the sample to equity REITs only. The Ziman database provides comprehensive REIT information such as stock returns, stock price, market capitalisation, REIT property type, etc. Both monthly and daily price/return data were retrieved from the database. The sample period is from January 1980 to December 2011[11]. The sample contains 453 equity REITs on the US market. Table 1 gives the number of REITs by year in the sample. On average, the number of REITs in the sample was 134 each year.

[Insert Table 1 here]

We constructed controlling variables including the logarithm of market capitalisation (ME), momentum (MOM), lottery-like return (MAX), cumulative returns from quarter q-5 to quarter t-1 (RETq-5, q-1), cumulative returns from quarter q-2 to quarter t-1 (RETq-2, q-1), stock turnover (TURNOVER), and skewness of stock returns (SKEW) from the data in the CRSP/Ziman database. Financial statement data for the REITs in the sample were collected from Compustat and used to construct control variables, including book-to-market ratio (BM), asset growth (AG), returns on equity (ROE), the logarithm of price (LNP), and dividend yield (DY). The variable definitions are given in Appendix A. To remove outliers, the variables were winsorized at 1% and 99% percentiles.

REIT beta in a month t is calculated as slope coefficient from a regression of excess REIT returns on excess market return based on daily returns from the previous 12 months (Bali et al., 2017; Novy-Marx, 2016). At least 200 daily observations are required for each regression. The beta is used to sort REITs for a month ahead (month t+1). Alternatively, beta is created based on the standard deviations of REIT returns and market returns, and the correlation between REIT and market returns. This beta is used to construct the betting-against-beta (BAB) factor, following Frazzini and Pedersen (2014). The details of beta calculation and BAB construction are contained in Appendix B.

The institutional ownership data on REITs were collected from Thomson Reuters Institutional Holdings (13F). Institutional ownership was calculated as the percentage of shares held by institutional investors in a quarter. The Fama-French three factors as well as momentum factor

[11] As it requires a two-year horizon to estimate the beta for each REIT, the period to calculate beta anomaly starts from January 1982.

were extracted from Kenneth French's database. The returns on 10-year bonds were retrieved from CRSP to construct the Van Nieuwerburgh (2019) factors.[12]

Table 2 reports summary statistics of the variables. The average beta calculated from the regression is 0.51, and the average of BAB beta is 0.737. Beta in the BAB strategy is larger because a shrinkage method is applied to the BAB beta (see discussion in the Appendix B). The average monthly REIT return is 1.04%. REITs, on average, have a book-to-market ratio of 0.965, returns on equity of 5%, and dividend yield of 6.9%. The average institutional ownership in REITs in a quarter is 47.4%.

[Insert Table 2 here]

Table 3 presents the average values of some firm characteristics in the groups sorted by beta. The results show that low-beta REITs have smaller market capitalisation and higher book-to-market ratios than high-beta REITs, which is consistent with the finding for the general stock market (Novy-Marx, 2016). However, the low-beta REITs have lower profitability (ROE) and insignificant difference in asset growth to high-beta REITs, contrary to the argument that low-beta firms have relatively high profit and conservative investment (Novy-Marx and Velikov, 2018). Our results also show that the lottery-like return (MAX) is similar in both the low-beta REITs and high-beta REITs, which is inconsistent with the finding for the general stock market that beta is positively associated with lottery-like return in a stock (Bali et al., 2017). The results may not support the explanation that beta anomaly is driven by differences in the characteristics between high-beta and low-beta stocks; for instance, high-beta stocks have a low risk-adjusted return because they are unprofitable and lottery-like stocks (Novy-Marx, 2016; Bali, et al., 2017; Liu, Stambaugh and Yuan, 2018). Low-beta REITs exhibit greater skewness of stock returns than high-beta RETIs. It is also found that high-beta REITs have significantly greater institutional ownership than low-beta REITs.

[Insert Table 3 here]

Empirical Results

[12] The Van Nieuwerburgh five-factor model, which is proposed by Van Nieuwerburgh (2019), can be regarded as an augmented version of the Fama-French three-factor model by adding the 10-year bond returns as interest rate risk premium and the momentum factor. Van Nieuwerburgh (2019) argues that this five-factor model "explains a large fraction of the variations in REIT returns".

Beta anomaly in the REIT market

To demonstrate the beta anomaly, REITs are sorted into quintile portfolios based on their betas in the previous month (Bali et al., 2017; Liu, Stambaugh and Yuan, 2018). The beta anomaly is estimated from the risk-adjusted return on a long-short portfolio: long the REITs with lowest 20% betas and short the REITs with highest 20% betas. The risk-adjusted return is the alpha of the long-short portfolio estimated from the CAPM model, Fama-French three-factor model, and the Van Nieuwerburgh five-factor model[13]. Both equal-weighted portfolio return and value-weighted portfolio return are reported. The *t-statistics* of the portfolio returns are estimated from Newey and West (1987) standard errors with 6 months.

We also constructed a BAB strategy in the REIT market following Frazzini and Pedersen (2014). To construct the BAB factor, all REITs were assigned to two portfolios based on their estimated beta. The REITs with a beta below (above) the cross-section beta median were classified as low (high) beta portfolios. The portfolios were rescaled to a beta of one. The BAB factor is a zero-investment and zero-beta strategy by short the high-beta deleveraged portfolio and long low-beta leveraged portfolio.[14] The detailed method is given in Appendix B.

In Table 3 the excess returns and abnormal returns are reported, on the REIT portfolios sorted by beta. Panel A presents returns of the equal-weighted portfolios. Column (1) shows that high-beta REITs earn more excess returns (raw return net of risk-free rate) than low-beta REITs, although the return on low-minus-high beta portfolio is insignificant. High-beta REITs generate higher returns to compensate for the exposure to market risk (measured by the beta). Columns (2)-(5) present the risk-adjusted abnormal returns. After considering market risk, Fama-French factors and Van Nieuwerburgh factors, low-beta REITs yield higher risk-adjusted returns than high-beta REITs. The risk-adjusted return on low-minus-high portfolio is a significant 0.368% per month from the Fama-French three-factor model.

[Insert Table 4 here]

Panel B presents the excess returns and abnormal returns of the value-weighted portfolios. The low-minus-high beta portfolio earns insignificantly positive excess returns of 0.066% per

[13] Previous studies use the Fama-French three-factor model to test beta anomaly in the general stock market (Frazzini and Pedersen, 2014, Liu, Stambaugh and Yuan, 2018). The model is also applied in the REIT asset pricing studies (e.g., Peterson and Hsieh, 1997; Anderson et al., 2005). The Van Nieuwerburgh five-factor model is also used as the model can better capture the risk and returns in the REIT market (Van Nieuwerburgh, 2019).

[14] The BAB strategy differs from a simple low-minus-high beta strategy as it rescales the high-beta and low-beta portfolios to have a beta of one. It is a zero-investment and zero-beta strategy. The low-minus-high beta strategy is only a zero-investment strategy.

month. The risk-adjusted returns on the portfolio are all significantly positive, ranging from 0.354% per month from CAPM (t-statistic = 1.99) to 0.622% per month for the Van Nieuwerburgh five-factor model (t-statistic = 2.70). The results are consistent with previous studies of the general stock market that low-beta stocks earn higher risk-adjusted returns than high-beta stocks (Bali et al., 2017; Liu, Stambaugh and Yuan, 2018).

Beta anomaly in the REIT market is also demonstrated in the BAB strategy (Frazzini and Pedersen, 2014). Panel C reports the returns on the strategy. REITs are sorted into two groups based on their betas, and the betas of two groups are scaled to a beta of one[15]. The excess return on the BAB portfolio is a significant 0.621% per month with a t-statistic of 2.15. The abnormal returns on the BAB portfolio are all positive and significant: 0.697% from CAPM, 0.741% from the Fama-French three-factor model, and 0.775% from the Van Nieuwerburgh five-factor model. These findings confirm that the abnormal return from the BAB strategy, which is well-documented in the general stock market (Frazzini and Pedersen, 2014), also exists in the REIT market. Notice that the BAB anomaly comprises both the beta anomaly (the simple long-short portfolio) and the rescaled part (leverage the low-beta portfolio and deleverage the high-beta portfolio). The magnitudes of BAB anomaly are larger than the beta anomaly for the simple low-minus-high beta portfolio.

Overall, the above results demonstrate a beta anomaly in the REIT market. Several additional tests were made of whether the beta anomaly is robust by: (1) restricting the sample to the largest 50% equity REITs and (2) calculating the betas based on weekly stock returns. The results remain similar.[16] The security market line in the REIT market and the line implied by CAPM are plotted in Figure 1. The security market line is apparently flatter than the CAPM implies, consistent with the argument in Black (1972).[17] Combined together, the findings support the first hypothesis that the beta anomaly exists in the REIT market.

[Insert Figure 1 here]

Previous studies argue that the structural change of REITs in the early 1990s leads the REIT market to be similar to the stock market (Glascock, Lu and So, 2000; Chan, Leung and Wang,

[15] Following Frazzini and Pedersen (2014), we sort the REITs into high-beta group and low-beta based on the cross-section median.
[16] These results are not reported but available upon the request.
[17] We also plotted security market line for general stock market using stock constituents of S&P500 index. The security market line in the general stock market is flatter than the line in the REIT market, indicating a larger beta anomaly in the general stock market.

2005). We explore the beta anomaly separately in two periods: the Vintage REIT Era (1982-1993) and the New REIT Era (1994-2017).

[Insert Table 5 here]

In Table 5, the returns are reported on the low-minus-high beta portfolio in these two periods. The risk-adjusted returns from long low-beta REITs and short high-beta REITs are all insignificant and even negative in the Vintage REIT Era. Neither are the abnormal returns to BAB strategy significant in the period. The result is consistent with previous studies that REITs are more similar to bonds in the Vintage Era (Peterson and Hsieh, 1997; Karolyi and Sanders, 1998). Therefore, the REIT returns do not bear a strong relationship to the stock market and the beta does not play a major role in determining the cross-sectional returns of REITs (Chen, Hsieh, Vines and Chiou, 1998).

The abnormal returns on the long-short portfolios are positive and significant in the New REIT Era. Alphas from CAPM, the Fama-French three-factor model and the Van Nieuwerburgh five-factor model are 0.404%, 0.556% and 0.426% per month in the equal-weighted portfolio. The alphas from the value-weighted long-short portfolio and the BAB portfolio are also all significantly positive and the magnitudes are even greater than the alphas from equal-weighted portfolios. These abnormal returns are economically significant. In sum, hypothesis H1a is confirmed, that the beta anomaly exists only in the New REIT Era when REITs become more stock-like assets.

Cross-sectional analysis of the beta anomaly

The Fama-MacBeth regression was run to test the relationship between beta and REIT stock returns, and explore whether the relationship is driven by effects from other firm characteristics. The cross-sectional equation is given as (Bali et al., 2017):

$$RET_{i,t} = \alpha_t + \gamma_t Beta_{i,t-1} + \delta_t Controls_{i,t-1} + \varepsilon_{i,t} \qquad (1)$$

, where $RET_{i,t}$ is the excess returns of REIT i in month t. $Beta_{i,t-1}$ is the beta of REIT i in month *t-1*. $Controls_{i,t-1}$ are control variables, including book-to-market ratio (BM), market capitalisation (ME), momentum (MOM), asset growth (AG), returns on equity (ROE), lottery-like return (MAX), and skewness (SKEW). A negative coefficient on beta indicates that high-beta REITs earn lower returns than low-beta REITs. The coefficient for beta should be insignificant if some firm characteristics can drive the beta anomaly, e.g., profitability, skewness of stock returns and lottery-like stock return, are included in the regressions.

The regression results are reported in Table 6. The baseline model includes the book-to-market ratio, market capitalisation and momentum as controlling variables. Column (1) gives the results of the regression in the overall sample period. The coefficient estimate for the beta is negative and significant at the 10% level. The result indicates that after controlling for the book-to-market ratio, market cap and past stock return in a REIT, a one-unit increase in beta reduces REIT stock returns by 0.503% per month. The result is consistent with the findings from the portfolio analysis in the previous section that high-beta REITs are associated with low stock return. Columns (2) and (3) show that the negative relationship between beta and REIT stock return is only significant in the New REIT Era. Beta cannot significantly affect REIT stock return in the Vintage REIT Era and its coefficient even becomes positive. The results confirm again that beta anomaly only exists in the New REIT Era.

Column (4) presents the results of the regression with some firm characteristics that may drive the beta anomaly, including profitability and investment (Novy-Marx and Velikov, 2018), the maximum daily return over the past one month (Bali et al., 2017) and skewness of stock return (Schneider, Wagner and Zechner, 2020).[18] The coefficient for the beta is still negative and significant in the New REIT Era, indicating that the negative relationship between beta and REIT stock return is not caused by a beta correlation with these firm characteristics. The result shows that the proxy for investor's demand for lottery-like stocks (MAX) is negatively associated with stock returns, consistent with Bali, Cakici and Whitelaw (2011) that lottery-like stocks earns lower returns. Although previous studies show that investment and profitability can predict stock returns in the REIT market (Bond and Xue, 2017; Ling, Ooi and Xu, 2019), our results do not show any significant relationship between investment or profitability and REIT stock returns. Schneider, Wagner and Zechner (2020) reveal a significant negative relationship between skewness and future returns in the stock market. Our results, however, show that the association between skewness and future returns in the REIT market is weak.

[18] Novy-Marx and Velikov (2018) argue that low-beta stocks earn larger risk-adjusted return than high-beta stocks because low-beta stocks are with higher profitability and lower investment. Bali et al. (2017) find that high-beta firms are lottery-like stocks and their prices are pushed up by lottery demand of investors, which lead to low risk-adjusted return in these stocks and hence beta anomaly. Schneider, Wagner and Zechner (2020) argue that the beta anomaly is caused by the compensation of skew risk among the low beta firms.

Overall, the cross-sectional regression analysis confirms again that the existence of beta anomaly in the REIT market is only significant in the New REIT Era. Furthermore, we show that the beta anomaly in the REIT market does not disappear after taking into consideration some firm characteristics that may drive the beta anomaly in the general stock market. The results reject the second hypothesis.

[Insert Table 6 here]

Leverage constraint hypothesis and beta anomaly: evidence from institutional ownership

We turn to test whether the leverage constraint hypothesis (Black, 1972) can explain the beta anomaly in the REIT market. It argues that the beta anomaly is driven by leverage constrained investors, such as mutual funds, that increase exposure to high-beta stocks so as to beat the market (Frazzini and Pedersen, 2014; Christoffersen and Simutin, 2017). Following this argument, it is expected that institutional ownership in REITs increases with beta, holding other firm characteristics constant. To test the hypothesis H3, an OLS regression was constructed of institutional ownership on beta and other controlling variables that can determine institutional ownership, including proxies for prudence, liquidity and past stock returns (Del Guercio, 1996; Gompers and Metrick, 2001). The variables related to firm characteristics that may drive the beta anomaly are also included. The regression equation is given as (Gompers and Metrick, 2001; Ferreira and Matos, 2008):

$$IO_{i,t} = \alpha + \gamma Beta_{i,t-1} + \delta Controls_{i,t-1} + Property_i + Year_t + \varepsilon_{i,t} \qquad (2)$$

, where $IO_{i,t}$ is the institutional ownership of REIT i in quarter t; $Beta_{i,t-1}$ is beta of REIT i estimated at the end of quarter *t-1*, and $Controls_{i,t-1}$ are control variables. We include property type fixed effect $Property_i$ and year fixed effect $Year_t$ to account for the institutional preference for different types of property and time-series variations. The *t-statistics* are calculated based on robust standard errors clustered by property type (Petersen, 2009). If institutional investors prefer high-beta REITs due to their leverage constraint and to beat the benchmark, the coefficient for beta is expected to be positive.

The regression results from Equation (2) are reported in Table 7. Column (1) shows the full period regressions from 1982-2017. The result indicates a significantly positive coefficient of beta (t-statistic = 3.75): a one-unit increase in beta would cause an 8.4% increase in institutional ownership in the REITs in a quarter, holding other firm characteristics constant. Notice that in general, institutional investors reduce ownership in REITs with large stock return volatility, which is consistent with prudence considerations in the financial institutions (Gompers and Metrick, 2001). A preference of institutional investors for high-beta REITs is not consistent with prudence considerations or diversification motives of institutional investments in the REIT market, but aligns with the conjecture in the leverage constraints hypothesis that financial institutions tend to tilt their portfolios toward high-beta assets for high return and to beat the benchmark.

Institutional investors also prefer the REITs of large firms with high stock prices and high stock turnovers probably because these REITs can provide good liquidity (Gompers and Metrick, 2001; Ciochetti, Craft and Shilling, 2003). REITs with high book to market ratio and strong past performance also attract more institutional investments. Interestingly, the results show that institutions invest more in REITs with low dividend yield and poor profitability. Institutional ownership is lower in those REITs that are more likely to be lottery-like stocks, which is consistent with Bali et al. (2017) who state that lottery-like stocks are preferred by unsophisticated individual investors. In sum, the results demonstrate that institutional investors prefer high-beta REITs, supporting H3 and the conjecture that low risk-adjusted return on the high-beta stocks is caused by the exposure of institutional investors to these firms.

[Insert Table 7 here]

Columns (2) and (3) report the results of institutional ownership in the Vintage REIT Era and the New REIT Era separately. The results indicate that institutional investors only prefer high-beta REITs in the New REIT Era. The coefficients for beta are small and insignificant in the regression of the Vintage REIT Era , while highly significant in the regression of the New REIT Era. The changes of institutional investor preference in the REIT market are coincident with the existence of a beta anomaly, indicating that institutional investments in the high-beta REITs could be a driving force behind the low risk-adjusted return in these securities. The findings confirm H3a. In sum, the increasing institutional ownership in REITs after the early 1990s and the preference of institutional investors for high-beta REITs could explain the beta anomaly in the REIT market.

Conclusions

The beta anomaly has been documented in the asset pricing literature for a long time (Friend and Blume, 1970; Black, Jensen, and Scholes, 1972). A recent study by Frazzini and Pedersen

(2014) showed that the beta anomaly exists in the US equity market, international equity markets, US Treasury bonds and corporate bonds markets, and futures market. This research has extended those to the real estate market and explored whether the security market line in the REIT market is also flatter than CAPM implies.

In the study, the beta anomaly is shown to exist within the REITs market in the cases of a long-short strategy with long low-beta REITs and short high-beta REITs and a BAB strategy (Frazzini and Pedersen, 2014). Consistent with the findings for the general stock market, high-beta REITs earn significantly lower risk-adjusted returns in comparison with low-beta REITs. The beta anomaly, however, only became significant in the New REIT Era when REITs become stock-like securities. The negative relationship between beta and REIT return remains robust even when some firm characteristics such as profitability, lottery-like return and skewness of stock return are taken into account, which rejects the explanation that the beta anomaly itself, is driven by beta's correlation with these characteristics (e.g., Bali et al., 2017). This study has shown that beta in the REITs market is positively and significantly associated with institutional ownership, suggesting that institutional investors prefer high-beta REITs. The finding lends support to the leverage constraints hypothesis (Black, 1972), arguing that due to leverage constraints, investors tend to increase their exposure to riskier assets and it is the overweighting in high-beta stocks that causes the beta anomaly. Overall, this research confirms that the beta anomaly exists in the real estate market and could be driven by the preference of institutional investors for high-beta REITs.

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Table 1 Number of equity REITs by year

Year	Number of REITs	Year	Number of REITs
1982	53	2000	185
1983	55	2001	173
1984	54	2002	163
1985	55	2003	161
1986	66	2004	159
1987	77	2005	163
1988	86	2006	163
1989	84	2007	143
1990	84	2008	121
1991	86	2009	116
1992	106	2010	118
1993	110	2011	128
1994	166	2012	132
1995	199	2013	143
1996	197	2014	160
1997	192	2015	176
1998	199	2016	181
1999	194	2017	184
		Average	134.19
		Total	453

Note: This table presents the number of REITs each year. The sample contains equity REITs in the US market from January 1982 to December 2017. We restrict our sample with available beta and no missing returns. The last two rows report the average number of REIT each year and the total number of unique REIT.

Table 2 Summary statistics

Variables	Obs.	Mean	Median	SD	Min	Max
Monthly variables:						
Beta	53,926	0.510	0.390	0.455	-1.230	2.472
Beta (BAB)	52,904	0.737	0.687	0.258	-0.698	1.966
RET(%)	53,926	1.04	0.9	9.043	-53.306	74.967
BM	51,630	0.965	0.741	0.899	0.103	6.424
Ln(ME)	52,536	5.743	5.949	2.023	0.937	9.843
MOM	53,311	0.104	0.102	0.264	-0.652	1.022
AG	51,080	0.251	0.066	0.650	-0.396	4.794
ROE	51,344	0.050	0.060	0.139	-0.751	0.505
MAX	53,925	0.024	0.018	0.022	0.002	0.141
SKEW	53,926	0.102	0.097	0.628	-15.905	15.929
Quarterly variables:						
IO	15,415	0.477	0.466	0.351	0.000	1.000
VOLATILITY	15,415	0.078	0.062	0.058	0.015	0.977
TURNOVER	15,415	0.093	0.065	0.094	0.000	0.530
LNP	15,415	2.810	2.896	0.890	-0.134	4.872
$RET_{q-2, q-1}$	15,415	0.031	0.030	0.140	-0.413	0.500
$RET_{q-5, q-1}$	15,415	0.127	0.124	0.296	-0.672	1.161
DY	15,415	0.070	0.064	0.049	0.000	0.303

Note: this table presents the summary statistics. The sample contains listed equity REITs in the US market from January 1982 to December 2017. The monthly variables include beta from daily returns regression (Beta), beta (BAB) calculated by the betting against beta method in (Frazzini and Pedersen, 2014), returns in percentage (RET%), book-to-market ratio (BM), the logarithm of market capitalisation, momentum (MOM), asset growth (AG), returns on equity (ROE), lottery-like return (MAX) and skewness (SKEW). The quarterly variables include percentage of institutional ownership (IO), stock return volatility (VOLATILITY), stock turnover (TURNOVER), the logarithm of price (LNP), cumulative returns from quarter q-2 to quarter t-1 ($RET_{q-2, q-1}$), cumulative returns from quarter q-5 to quarter t-1 ($RET_{q-5, q-1}$), and dividend yield (DY). The variable definitions are contained in Appendix A.

Table 3 Firm characteristics in different beta quintiles

Variables	Low	2	3	4	High	Low-High	t-statistics
Beta	0.123	0.385	0.490	0.596	0.825	-0.702	(-25.44)***
Beta (BAB)	0.509	0.661	0.728	0.795	0.939	-0.430	(-30.27)***
BM	1.293	0.943	0.866	0.865	1.029	0.264	(7.99)***
Ln(ME)	4.154	5.447	5.766	5.831	5.755	-1.601	(-17.68)***
MOM	0.080	0.107	0.109	0.116	0.099	-0.019	(-1.36)
AG	0.235	0.213	0.210	0.224	0.229	0.006	(0.21)
ROE	0.028	0.058	0.068	0.061	0.042	-0.014	(-1.87)*
MAX	0.029	0.022	0.022	0.023	0.029	-0.000	(-0.11)
SKEW	0.263	0.176	0.109	0.099	0.116	0.147	(3.42)***
IO	0.237	0.430	0.468	0.472	0.465	-0.228	(-9.67)***
Volatility	0.088	0.071	0.072	0.075	0.097	-0.009	(-1.27)
TURNOVER	0.055	0.081	0.087	0.093	0.101	-0.046	(-3.28)***
LNP	2.324	2.858	2.943	2.877	2.629	-0.305	(-3.83)***
$RET_{q-2, q-1}$	0.023	0.032	0.035	0.032	0.030	-0.008	(-1.41)
$RET_{q-5, q-1}$	0.099	0.126	0.131	0.141	0.121	-0.022	(-1.21)
DY	0.067	0.071	0.073	0.074	0.074	-0.007	(-1.61)

Note: this table presents the summary statistics of the variables in the sample. The table reports the mean of variables in the quintile portfolios sorted by beta. The differences of average values in the low-beta portfolio and high-beta portfolio (Low-High) and t-statistics are also reported. The variable definitions are contained in Appendix A. The t-statistics reported in parentheses are adjusted by Newey-West standard errors with 6-month lag. ***1%, **5%, and *10%.

Table 4 Returns of the beta-sorted portfolios and BAB

Panel A: Returns and alphas of equal-weighted portfolios

	Excess Returns	CAPM alpha	FF3 alpha	VN5 alpha
	(1)	(2)	(3)	(4)
Low	0.585	0.260	0.070	0.499
2	0.658	0.286	0.033	0.607
3	0.786	0.374	0.103	0.729
4	0.807	0.327	0.046	0.632
High	0.697	0.084	-0.299	0.420
Low-High	-0.111	0.176	0.368	0.079
t-statistics	(-0.63)	(1.01)	(2.05)**	(0.34)
N of Month	432	432	432	432

Panel B: Returns and alphas of value-weighted portfolios

	Excess Returns	CAPM alpha	FF3 alpha	VN5 alpha
	(1)	(2)	(3)	(4)
Low	0.629	0.303	0.109	0.711
2	0.566	0.228	0.004	0.504
3	0.593	0.172	-0.076	0.605
4	0.875	0.416	0.163	0.599
High	0.564	-0.050	-0.398	0.089
Low-High	0.066	0.354	0.508	0.622
t-statistics	(0.34)	(1.99)**	(2.82)***	(2.70)***
N of Month	432	432	432	432

Panel C: Returns and alphas of the BAB strategy

	Excess Returns	CAPM alpha	FF3 alpha	VN5 alpha
	(1)	(2)	(3)	(4)
Low	1.303	0.754	0.459	1.105
High	0.681	0.056	-0.282	0.329
BAB (Low-High)	0.621	0.697	0.741	0.775
t-statistics	(2.15)**	(2.25)**	(2.30)**	(2.17)**
N of Month	432	432	432	432

Note: This table shows the returns on beta-sorted portfolios. The sample contains listed equity REITs in the US market from January 1982 to December 2017. The abnormal returns are estimated from the CAPM model (CAPM alpha), the Fama-French three-factor model (FF3 alpha), and the Van Nieuwerburgh five-factor model (VN5 alpha). Panel A and Panel B show the returns of equal-weighted portfolios and value-weighted portfolios sorted by beta. The returns on the low-minus-high beta portfolio are also presented. Panel C gives the returns of the BAB strategy following Frazzini and Pedersen (2014). The variable definitions are contained in Appendix A. The t-statistics reported in parentheses are adjusted by Newey-West standard errors with 6-month lag. ***1%, **5%, and *10%.

Table 5 Alphas on the low-minus-high beta portfolios in the Vintage REIT Era and New REIT Era

Period	Time-Span	Month	CAPM alpha	FF3 alpha	VN5 alpha
Equal-weighted:					
Vintage REIT Era	1982-1993	144	-0.278	-0.228	-0.120
			(-0.92)	(-0.66)	(-0.42)
New REIT Era	1994-2017	288	0.404	0.556	0.426
			(2.25)**	(3.23)***	(2.44)**
Value-weighted:					
Vintage REIT Era	1982-1993	144	-0.348	-0.332	-0.247
			(-1.11)	(-0.90)	(-0.72)
New REIT Era	1994-2017	288	0.703	0.827	0.554
			(3.80)***	(4.73)***	(3.05)***
BAB:					
Vintage REIT Era	1982-1993	144	0.461	0.286	1.854
			(0.60)	(0.37)	(0.73)
New REIT Era	1994-2017	288	0.814	0.871	0.446
			(3.82)***	(3.88)***	(1.74)*

Note: This table shows the abnormal returns on low-minus-high beta portfolios and BAB portfolio. The tables report the alphas from the CAPM model (CAPM alpha), the Fama-French three-factor model (FF3 alpha), and the Van Nieuwerburgh five-factor model (VN5 alpha). The abnormal returns are reported in the Vintage REIT Era (1982-1993) and the New REIT Era (1994-2017) separately. The low-minus-high beta portfolios includes the equal-weighted portfolio, the value-weighted portfolio and the BAB strategy. The variable definitions are contained in Appendix A. The t-statistics reported in parentheses are adjusted by Newey-West standard errors with 6-month lag. ***1%, **5%, and *10%.

Table 6. Fama-MacBeth regressions

	Full Period	Vintage Era	New Era	New Era
	(1)	(2)	(3)	(4)
Intercept	0.556	0.610	0.529	0.997
	(1.74)*	(1.11)	(1.36)	(2.43)**
Beta	-0.503	0.033	-0.771	-0.634
	(-1.65)*	(0.07)	(-2.07)**	(-2.00)**
BM	0.142	-0.037	0.231	0.242
	(1.26)	(-0.19)	(1.71)*	(1.65)*
Ln(ME)	-0.034	-0.070	-0.016	-0.067
	(-0.63)	(-0.56)	(-0.32)	(-1.43)
MOM	0.593	1.173	0.303	0.148
	(1.26)	(1.78)*	(0.49)	(0.27)
AG				0.021
				(0.14)
ROE				0.349
				(0.55)
MAX				-13.909*
				(-1.65)
SKEW				-0.061
				(-0.36)
N. of months	432	144	288	288
Adj. R2	0.095	0.062	0.111	0.162

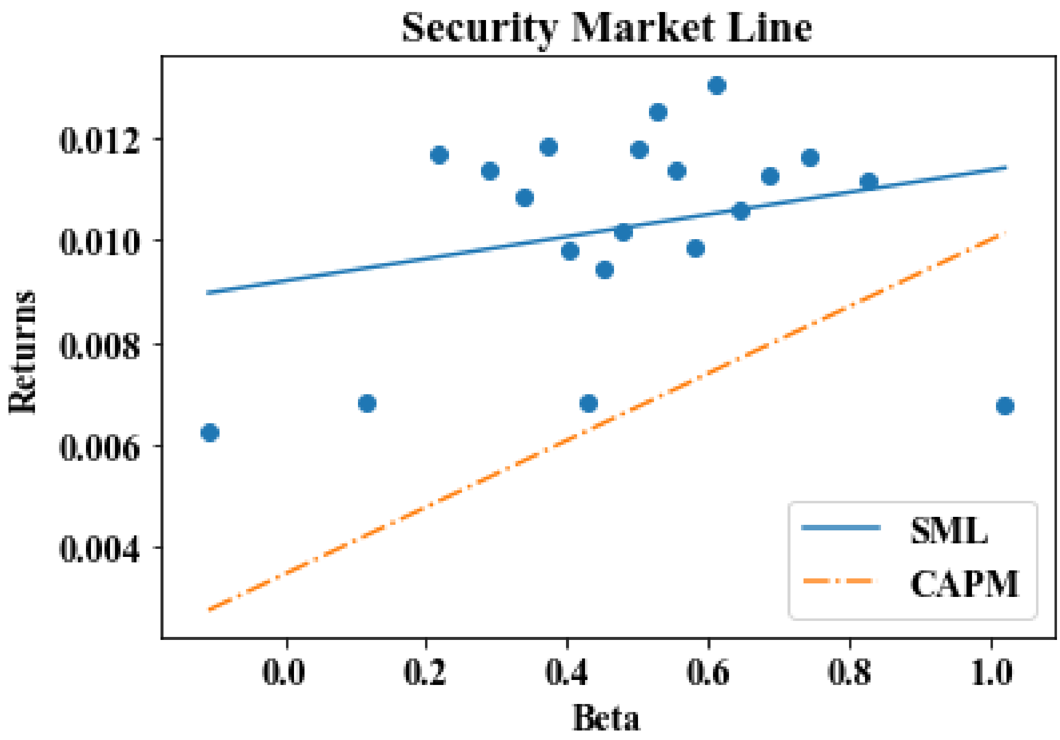
Note: This table presents the results of the Fama-MacBeth regressions of REITs returns on beta using Equation (1). The Fama-MacBeth regression conduct the cross-sectional regression of future returns on beta and control variable in each month. The coefficients reported are the average value of the coefficients from 432 regressions. The baseline model includes book-to-market ratio (BM), log of market capitalisation (ME) and momentum (MOM) as controlling variables. Column (1) indicates the result of the regression from the full sample period (1982-2017). Columns (2) and (3) report the results from the regressions for the Vintage REIT Era (1982-1993) and the New REIT Era (1993-2017) separately. The last column adds extra controlling variables, including asset growth (AG), returns on equity (ROE), lottery-like return (MAX), and skewness (SKEW) to the regression in the New REIT Era. The t-statistics reported in parentheses are adjusted by Newey-West standard errors with 6-month lag. ***1%, **5%, and *10%.

Table 7 OLS regressions of institutional ownership on beta

	Full Period	Vintage Era	New Era
Intercept	-0.190	-0.082	-0.199
	(-2.57)**	(-3.75)***	(-2.21)**
Beta	0.084	0.016	0.100
	(3.75)***	(0.65)	(4.07)***
BM	0.020	0.004	0.021
	(2.27)**	(0.78)	(2.10)**
Ln(ME)	0.075	0.048	0.076
	(15.09)***	(7.73)***	(11.51)***
Volatility	-0.078	-0.122	-0.052
	(-1.59)	(-1.70)*	(-0.93)
TURNOVER	0.806	0.478	0.776
	(5.37)***	(2.05)**	(4.99)***
LNP	0.051	0.027	0.056
	(1.80)*	(2.66)***	(1.65)*
$RET_{q-2, q-1}$	0.052	0.019	0.055
	(8.42)***	(3.33)***	(15.03)***
$RET_{q-5, q-1}$	0.051	0.030	0.062
	(9.07)***	(3.57)***	(12.03)***
DY	-0.411	-0.243	-0.446
	(-6.38)***	(-5.15)***	(-4.47)***
AG	0.011	-0.008	0.017
	(1.32)	(-0.54)	(1.52)
ROE	-0.168	-0.078	-0.193
	(-5.53)***	(-2.29)**	(-3.64)***
MAX	-0.788	-0.404	-0.990
	(-5.07)***	(-5.12)***	(-4.82)***
SKEW	-0.004	-0.004	-0.005
	(-0.88)	(-1.88)*	(-0.51)
Property Type Fixed Effect	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes
Obs.	15,415	2,818	12,597
Adj. R2	0.697	0.334	0.642

Note: This table reports the results of OLS regressions of institutional ownership on beta in the REIT market using Equation (2). The control variables include book-to-market ratio (BM), the logarithm of market capitalisation, volatility, turnover, the logarithm of price (LNP), cumulative returns from quarter q-2 to quarter t-1 ($RET_{q-2, q-1}$), cumulative returns from quarter q-5 to quarter t-1 ($RET_{q-5, q-1}$), dividend yield (DY), asset growth (AG), returns on equity (ROE), lotter-like return (MAX), and skewness (SKEW). Property type fixed effect and year fixed effect are also included. The results from the regressions based on the full sample period (1982-2017), the Vintage REIT Era (1982-1993) and the New REIT Era (1993-2017) are reported separately. The t-statistics calculated by robust standard errors clustered by property type are reported in parentheses. ***1%, **5%, and *10%.

Figure 1. CAPM and Security Market Line



Note: the figure plots the CAPM line and security market line of equity REITs. The sample period from January 1982 to December 2017. Security market line is plot by sorting REITs into equally 20 groups based on their beta. The stock returns and corresponding betas of 20 groups are shown as blue dots. The security market line is a linear fitted curve from the observations.

Appendix A. Variable definition

Variable	Definition
Beta	Stock beta from the market model. Beta is the coefficient on market excess return from a regression of excess REIT returns on market excess return using daily returns in the past 12 months (at least 200 daily observations).
Beta (BAB)	Beta for the BAB strategy; see the discussions in Appendix B
BM	Book-to-market ratio; book value of equities divided by market capitalisation at the end of the previous year
Ln(ME)	Market capitalisation. The natural logarithm of market capitalisation at the end of the previous year
MOM	Momentum; the cumulative returns from prior 12 to prior 2 months
AG	Asset growth ratio; the growth in non-cash assets in the previous year
ROE	Return on equity; net income divided by the book value of equities in the previous year
MAX	Lottery-like return; the average of the highest five-day returns in the previous month (at least 15 daily observations).
SKEW	Skewness of the returns; the skewness of the daily stock returns in the past 12 months (at least 200 daily observations).
IO	Percentage of shares held by institutions in a quarter
VOLATILITY	The standard deviation of the monthly returns over the past two years
TURNOVER	Stock turnover ratio; trading volume divided by shares outstanding in the prior quarter
LNP	Natural logarithm of the stock price at the previous fiscal year-end
$RET_{q-2, q-1}$	Cumulative returns from the prior 2 quarter to the prior 1 quarter
$RET_{q-5, q-1}$	Cumulative returns from the prior 5 quarter to the prior 1 quarter
DY	Dividend yield; dividend per share divided by stock price in the previous fiscal year-end

Appendix B. Construction of BAB factor

We closely follow the method of Frazzini and Pedersen (2014) to construct the BAB factor in the REIT market. There are three steps in the BAB strategies: (1) estimate the ex-ante beta of each security from daily REIT return and market return; (2) shrink the ex-ante beta to remove the outliers; (3) construct the BAB factor by long low-beta securities and short high-beta securities[19]. The ex-ante beta is defined as:

$$\hat{\beta}_{i,t}^{ts} = \hat{\rho}_{i,t} \frac{\hat{\sigma}_{i,t}}{\hat{\sigma}_{m,t}} \quad (3)$$

, where $\hat{\sigma}_{i,t}$ and $\hat{\rho}_{i,t}$ are the estimated standard deviation and correlation of a REIT *i* in month *t*, and $\hat{\sigma}_{m,t}$ is the standard deviation of market return. CRSP value-weighted market index is used to calculate the market return. We use the standard deviation of one-day log excess returns in the past one-year to calculate volatility $\hat{\sigma}_{i,t}$ and $\hat{\sigma}_{m,t}$, and three-day overlapping log excess returns in the past two-year to calculate correlation $\hat{\rho}_{i,t}$. We require at least 120 daily returns to calculate the volatilities and 252 daily returns to compute the correlations[20].

We shrink the beta $\hat{\beta}_{i,t}^{ts}$ obtained from Equation (3) by a shrinkage factor $s = 0.6$, and the cross-sectional mean of the market beta is assumed to be β^{XS} = 1:

$$\hat{\beta}_{i,t} = s \times \hat{\beta}_{i,t}^{ts} + (1 - s)\hat{\beta}^{XS} \quad (4)$$

[21]. REITs are classified by the beta into the low-beta group and the high-beta group based on the cross-sectional median of beta. In each portfolio, REITs are ranked in ascending order based on their betas and then weighted by their ranking order. A REIT with a lower (higher) beta would be given larger weights when it is in the low (high) beta group. The weights of each REIT is decided by the following simple algorithm:

$$w_t^H = k_t(z_t - \bar{z}_t)^+$$

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[19] See the pages 8 and 9 in Frazzini and Pedersen (2014)

[20] Frazzini and Pedersen (2014) state that correlation is more persistent and moves more slowly than volatility. Thus, they use a five-year horizon to estimate the correlation and a one-year horizon to estimate the volatility to reflect the contemporaneous risk level. Rather than using a five-year horizon to calculate the correlation, we use a two-year horizon to maintain the large sample size of REITs as some REITs have a relatively short history.

[21] Following Frazzini and Pedersen (2014), we choose the shrinkage factor of 0.6 for the construction of BAB factor in the REIT market. The shrinkage factor can be given by $w_{i,t} = 1 - \sigma_{i,t}^2/(\sigma_{i,t}^2 - \sigma_{xs,t}^2)$. $\sigma_{i,t}^2$ is the variance of the time-series beta of stock *i* at time *t*; where $\sigma_{xs,t}^2$ is the cross-sectional variance of the beta at time *t*. Frazzini and Pedersen (2014) estimate the average of the shrinkage factor in the stock market and find that in-the-sample mean shrinkage factor is 0.61. They use 0.6 as the shrinkage factor in the construction of the BAB factor.

$$w_t^L = k_t(z_t - \bar{z}_t)^- \tag{5}$$

, where w_t^H and w_t^L is the $n \times 1$ vector of weights for the REITs in the high-beta group and low-beta group respectively. z_t is the $n \times 1$ vector of the ranking order of $\hat{\beta}_{i,t}$ at time t, and $\bar{z}_t$ is the $n \times 1$ vector of the average rank $\bar{z}_t = 1_n' z_t / n_t$. The superscript of the bracket $(z_t - \bar{z}_t)^+$and $(z_t - \bar{z}_t)^-$ indicates the positive and negative differences between the ranking order and the average rank. The REIT with a positive (negative) difference is allocated to the high-beta (low-beta) group. k_t is a constant defined as $k_t = 2/1_{n,t}'|z_t - \bar{z}_t|$ to scale the difference between the difference and calculate the weight of each REIT. After the above algorithm, the sum of the weights for high-beta group w_t^H and the weights for low-beta group w_t^L should equal to 1.

To construct the BAB factor, we calculate the excess returns of high-beta portfolio and low-beta portfolio by the weighting scheme indicated above. The excess return is the raw portfolio return net of the risk-free rate. Both the high-beta portfolio and the low-beta portfolio are scaled to a beta of one respectively. The BAB is a market-neutral portfolio by long the leveraged low-beta portfolio and short the deleveraged high-beta portfolio. The algorithm can be indicated by:

$$r_t^{BAB} = \frac{1}{\beta_{t-1}^L}\left(r_t^L - r_t^f\right) - \frac{1}{\beta_{t-1}^H}\left(r_t^H - r_t^f\right) \tag{6}$$

, where r_t^{BAB} is the returns on the BAB factor at time *t*. The raw return of the low-beta portfolio r_t^L is given by $r_t^L = r_t' w_{t-1}^L$ and the raw return of high-beta portfolio r_t^H is $r_t^H = r_t' w_{t-1}^H$. r_t^f is the risk-free rate at time *t*. β_{t-1}^L is the scaling factor for the low-beta portfolio which is defined as $\beta_{t-1}^L = \beta_t' w_{t-1}^L$ and β_{t-1}^H is scaling factor for the high-beta portfolio which is defined as $\beta_{t-1}^H = \beta_t' w_{t-1}^H$.