INTERNATIONAL REAL ESTATE REVIEW

2019 Vol. 22 No. 3: pp. 399 – 430

Estimating the Cost of Equity Capital: Forecasting Accuracy for U.S. REIT Sector

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One of the fundamental concepts in financial economics is the cost of equity capital. The cost of equity is an important tool often used by a firm as a capital budgeting threshold for the required rate of return. The cost of equity of a firm also represents the compensation the market demands in exchange for owning the asset and bearing the risk of ownership. This paper focuses on the cost of equity capital estimates for a particular U.S. industry, the real estate investment trust (REIT) industry, to highlight the key role played by the choice of estimation method on the distant forecast. By using a comprehensive sample of 51 REITs over the period of January 1997 to December 2014, we compare the "hybrid beta" approach developed by Cosemans *et al.* (2016) with the Carhart four-factor model, the REIT-factor model in Chen *et al.* (2012) and the five-factor model formulated by Fama and French (2015). Our results demonstrate the superiority of the "hybrid beta" approach, which almost always produces, at the firm and portfolio-levels, absolute forecast errors that are lower than those of the other models implemented in our study.

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Keywords

Cost of Equity, Four-Factor, REIT-Factor, Five-Factor, Forecast Errors, Rolling Regression

1. Introduction

The cost of equity is an important concept for all industries, hence, it is vital to have an accurate and reliable benchmark on which to base new investment and capital budgeting decisions. For this reason, it is crucial to employ models that are able to predict excess total returns.

Modern finance theory "…requires knowledge of firm-specific betas that are difficult to estimate and may well be unstable over time" (Campbell *et al.* 2001). That is, managers need reliable estimates of the beta of their company and ensure that their exposure to risk remains within predetermined limits. Historically, the first theoretical method used to estimate the cost of the equity capital of a company was the capital asset pricing model (CAPM). However, many in the literature are critical of the CAPM. One of the reasons is that the pure-form of the CAPM almost always has an intercept above the risk-free rate. For this reason, estimates of the cost of equity are likely to systematically understate the true risk of any stock with a beta less than one, while systematically overstate the true risk of any stock with a beta that is more than one (Elton et al., 1994). Despite these issues, the CAPM is still widely used because it is simple and allows for ease of comparison among investment alternatives.

Another model that is used to explain the cost of equity capital is the arbitrage pricing theory (APT) model proposed by Ross (1976). In this model, the risk factors are not specified, but generally, different applications take macroeconomic risk factors into consideration. The cost of capital for investment varies according to the sensitivity of the investment to each of several risk factors. Nevertheless, the use of the APT model is still uncommon in professional practice because it is rather complex (to construct pure factor portfolios) and above all, there is no consensus on which macroeconomic risk factors are relevant enough to be taken into consideration.

Widely used to determine the cost of equity is the three-factor model developed by Fama and French in the early 1990s. Fama and French (1997) propose that the expected return of a security is contingent on its sensitivity to the market returns as well as size and book value.

Several studies have shown that momentum has critical importance in many different markets. Starting with Jegadeesh and Titman (1993), a substantial body of research in common stocks has documented economically large returns on strategies that buy past-12-month-return winners and sell short past losers. In the area of common stocks, momentum returns have posed great challenges to asset pricing models because evidence shows that momentum returns cannot be explained by the market beta or the size and book-to-market effects on returns. Carhart (1997) capture market-wide momentum profits by using a four-factor model. He investigates the momentum factor for a sample of mutual fund companies and his results indicate that momentum is statistically significant along with size and value factors.

The extant literature on the cost of equity capital for equity REITs is actually limited. There are many models that have been used to estimate the cost of capital, but few studies have examined the cost of equity capital for equity REITs, and even fewer have examined the forecasting ability of the models used to obtain the factor loadings. Arifin (2013) compared, for both the near and long-term horizons, the forecasting ability of full-sample and rolling regression models based on the CAPM and the three-factor model by using out-of-sample forecasts and exclusively examining the REIT sector. His results show that only for the more distant horizons does the accuracy of the estimates depend on the choice of the model used, while for the near term, the differences in the estimates are not so significant.

The emerging consensus among asset pricing specialists in the REIT sector is the need to explicitly control for a "REIT factor", although momentum has long been shown to have critical importance in explaining REIT returns. We refer to Chen *et al.* (2012) who demonstrate that the REIT-factor model provides incremental explanatory power for performance attribution models in REIT portfolios.

Glascock and Lu-Andrews (2018) follow the procedure developed by Pettengill *et al.* (1995) to obtain a better explanatory ability for REIT returns relative to beta. They find that a high beta REIT stock results in more positive returns when the obtained market returns exceed the risk-free rates, and more negative returns when the obtained market returns are lower than the risk-free rates.

So, to sum up, there are many multifactor models that have been used to estimate the cost of capital, but there is no consensus on which model provides a better analysis.

The goal of this study is to therefore identify a model that can be used by REIT industry practitioners to accurately estimate the cost of equity capital. In our analysis, we show that the "hybrid beta" approach offers statistically and economically significant out-of-sample benefits for investors by comparing its predictive ability to various simplified alternatives.

We compare the "hybrid beta" model developed by Cosemans *et al.* (2016) with other common tools used in practice in detail, that is, the Carhart four-factor model (1997), the REIT-factor model in Chen *et al.* (2012) and the five-factor model formulated by Fama and French (2015).

In particular, we use a comprehensive sample of 51 equity REITs with daily and monthly data from January 1997 to December 2014 to highlight that the hybrid beta estimator leads to significant gains in out-of-sample predictions of beta by estimating the cost of equity with each model mentioned above at the firm-level, and with the size decile of REIT portfolios, and a type portfolio.

In our analysis, we first estimate the cost of equity by using the hybrid beta (Cosemans *et al.* 2016), four-factor (Carhart 1997), REIT-factor (Chen *et al.* 2012) and five-factor (Fama and French 2015) models. Then, for the purpose of choosing an appropriate cost of capital model for discounting short-term vs. longer-term cash flows, we examine the efficacy of these models in forecasting the cost of capital.

It is often presumed that with the use of a time series analysis, the parameters of the model would be time-invariant. Nevertheless, it would be interesting to see if these parameters could remain constant over time due to changes in the economic environment. One of the ways to do so is to use a fixed sample size in calculating the parameter estimates over a rolling window in the model.

In reality, there is a lack of knowledge on how factor loadings can be truly produced. For this reason, we implement different estimation methods by using the four-factor, REIT-factor, and five-factor models; that is, 1-year, 3-year and 5-year rolling window ordinary least square (OLS) and full-sample OLS regressions. Due to the difficulty of validating the typology of a process that produces the factor loadings, we consider that the process could be one that is mean-reverting or a random walk. If the process is mean-reverting, better estimates should be obtained by using a full-sample regression because the mean-reversion is more likely captured by the average level over the long term. However, if the process is a random walk, the current level of risk is better captured by using a rolling regression. In general, we expect that precise estimates of the cost of equity capital are obtained by using rolling regressions.

The remainder of the paper is organized as follows. Section 2 provides the theoretical background of the three models employed in this study. Section 3 describes the data. Section 4 highlights a comparison between the forecasting errors produced by these models at the firm-level and portfolio-level. Finally, Section 5 offers our conclusions and suggestions for future research.

2. Theoretical Models

In this section, we describe the theoretical models that we use to estimate the cost of equity. The first model that we analyze is the “hybrid beta” model. Then, we provide an overview of alternative and current approaches that are commonly used as benchmarks by researchers and practitioners, that is, the four-factor (Carhart 1997), REIT-factor (Chen *et al.* 2012), and five-factor (Fama and French 2015) models.

2.1 "Hybrid Beta" Approach

Cosemans *et al.* (2016) propose a "hybrid beta" approach that combines a rolling window OLS beta with beta conditioned by using firm-specific information, and based on the economic theory.

For a reliable measure that is both efficient and robust, we use monthly sample estimates of betas that are obtained through rolling regressions of daily returns which provide the local fluctuations of the betas. After carrying out this step, we capture more distance information over time by combining the betas with prior betas.

Following this approach, we run the following regression:

$$r_{it,s} = a_{it} + \beta_{it} r_{Mt,s} + \epsilon_{it,s} \tag{1}$$

where $r_{it,s}$ and $r_{Mt,s}$ are the daily returns on REIT i (or portfolio i) and the market portfolio, respectively. The length of the estimation window is 125 days. The subscript *s* indexes the daily returns before the end of month *t*. We run a rolling window regression of daily returns for each month. The key point of these regressions is β_{it}. The risk-adjusted return is represented by a_{it} and the error term $\epsilon_{it,s}$ is normally distributed with a zero-mean and a variance of σ_{it}^2.

We incorporate observable firm-specific information by assigning a unique prior for the beta to each REIT *i* (or portfolio *i*). We shrink the rolling window estimates of the beta of a company based on Equation (1) towards its fundamentals-based prior. We find the fundamentals-based prior for the beta of each REIT (portfolio) i in month t, by estimating the panel regression with the use of monthly data:

$$R_{it} = \alpha_i^* + \beta_{it|t-1}^* R_{Mt} + \eta_{it} \tag{2}$$

where R_{it} and R_{Mt} are the monthly return in excess of REIT i and the market portfolio respectively; the intercept α_i^* is the risk-adjusted return; and η_{it} is an error term that is independent across stocks and normally distributed. The prior beta $\beta_{it|t-1}^*$ is parameterized as a linear function of the conditioning variables in order to link variation in the beta to firm-specific and macroeconomic fundamentals:

$$\beta_{it|t-1}^* = \delta_{0i} + \delta_{1i} X_{t-1} + \delta_2' Z_{t-1} + \delta_3' Z_{t-1} X_{t-1} \tag{3}$$

The state of the economy is represented by X_{t-1}, which denotes the default spread. By including this term, we are able to capture cyclical patterns in the beta estimates that are unrelated to the firm characteristics. Z_{t-1} is a vector of the instruments that contain lagged firm characteristics (e.g. measures of firm size, book-to-market value, operating and financial leverage, and momentum), which are chosen based on the findings in the literature on investment-based asset pricing. Since Petkova and Zhang (2005) point out the existence of a relationship between firm characteristics and beta over the business cycle, we include the interaction terms $Z_{t-1}X_{t-1}$ in our model. Equation (3) is substituted into Equation (2) to obtain the following expression:

$$\begin{aligned} R_{it} = \alpha_i^* + (\delta_{0i} + \delta_{1i}X_{t-1} + \delta_2' Z_{t-1} + \delta_3' Z_{t-1}X_{t-1})R_{Mt} \\ +\eta_{it}. \end{aligned} \quad (4)$$

The prior mean and variance for β_{it}, that is $\bar{\beta}_{it}$ and $\sigma^2_{\beta_{it}}$, in the rolling window regression of daily returns give rise to the posterior mean and variance of $\beta^*_{it|t-1}$, which are obtained from the monthly panel regression.

Vasicek (1973) combines the rolling window estimates of beta from daily returns with Equation (1) towards this prior belief, and develops a procedure that allows a shrunk estimate of the beta, which has an approximately normal distribution with the mean and variance respectively given by:

$$\tilde{\beta}_{it} = \frac{\bar{\beta}_{it}/\sigma^2_{\beta_{it}} + b_{it}/s^2_{b_{it}}}{1/\sigma^2_{\beta_{it}} + 1/s^2_{b_{it}}} \quad (5)$$

$$\tilde{\sigma}^2_{\beta_{it}} = \frac{1}{1/\sigma^2_{\beta_{it}} + 1/s^2_{b_{it}}} \quad (6)$$

where b_{it} is the sample estimate of β_{it} and $s^2_{b_{it}}$ is the OLS sampling variance of b_{it}.

Our main objective at this stage is to determine the so-called "hybrid beta", namely, the posterior mean $\tilde{\beta}_{it}$, which can be expressed as a weighted average of the prior mean and the rolling window estimate of the beta:

$$\tilde{\beta}_{it} = \phi_{it}\bar{\beta}_{it} + (1 - \phi_{it})b_{it} \quad (7)$$

where ϕ_{it} is the shrinkage weight given by:

$$\phi_{it} = \frac{s^2_{b_{it}}}{\sigma^2_{\beta_{it}} + s^2_{b_{it}}} \quad (8)$$

After a careful analysis of Equation (8), we note how the degree of shrinkage toward the prior is directly proportional to the precision of the sample estimate and the prior. That is, if the sample estimate is very imprecise, most of the weight will be given to the prior beta (i.e., a larger $s_{b_{it}}^2$ iwith respect to $\sigma_{\beta_{it}}^2$ means greater weight attributed to the prior beta).

Only after extracting the time series of the hybrid betas with monthly data for each REIT (portfolio) i can we estimate the cost of equity by using the following:

$$E(R_i) = R_f + \tilde{\beta}_i[E(R_M) - R_f] \tag{9}$$

where R_f is given by the one month Treasury bill rate and represents the risk-free rate, R_M is the return on the value-weighted market portfolio and $\tilde{\beta}_i$ is the hybrid beta given by Equation (7).

2.2 The Four-Factor and REIT-Factor Models

To enhance the power of the well-known three-factor model formulated by Fama and French in the early 1990s, Carhart (1997) developed the four-factor model by including an additional factor, i.e. momentum, which is the tendency of prices of assets that are rising to continue to rise, while those that are falling to continue to fall. Fama and French (1996) state that this additional momentum factor is motivated by the inability of the three-factor model to explain cross-sectional variables in the returns of a portfolio sorted by momentum.

The four-factor model is “consistent with a model of market equilibrium with four risk factors” (Carhart 1997). On the other hand, it may be “interpreted as a performance attribution model, where the coefficients and premia on the factor-mimicking portfolios indicate the proportion of mean return attributable to four elementary strategies: high versus low beta stocks, large versus small market capitalization stocks, value versus growth stocks, and one-year return momentum versus contrarian stocks” (Carhart, 1997:61).

The Carhart four-factor model is expressed as:

$$\begin{aligned} E(R_i) = R_f + b_i\left[E(R_M) - R_f\right] + s_i E(SMB) + \ h_i E(HML) \\ + m_i E(WML) \end{aligned} \tag{10}$$

where b_i, s_i, h_i and m_i represent the sensitivity of the return of REIT (portfolio) i to changes in the market premium $(R_M - R_f)$, size premium (SMB; that is, small minus big), value premium (HML; that is, high minus low) and momentum (WML; that is winners minus losers), respectively, in the regression:

$$\begin{aligned} R_i - R_f = a_i + b_i\left[R_M - R_f\right] + s_i SMB + \ h_i HML + m_i WML \\ + e_i. \end{aligned} \tag{11}$$

As in the three-factor model, the first factor is the market return in excess $(R_M - R_f)$, SMB is the return difference between a small-cap stock portfolio and a large-cap stock portfolio, HML is the return difference between a high-book-to-market stock portfolio and a low-book-to-market stock portfolio, and WML is the momentum factor formulated as winners minus losers. The latter is constructed as the difference between the returns in the portfolios of a winner and loser for a given set of assets.

On the other hand, the emerging consensus is on the criticality of the momentum factor, which points to the need to explicitly control REIT factors to better explain REIT returns. In this context, Chen *et al.* (2012) employ the REIT-factor model by using commonly accepted risk factors, such as those in the Fama and French (1993) three-factor model and the 1-year momentum factor presented in the four-factor model (Carhart 1997). They also incorporate a real estate factor in the analysis and estimate the performance of REIT portfolios in the presence of five factors:

$$\begin{aligned} R_i - R_f = a_i + b_i\left[R_M - R_f\right] + s_i SMB + h_i HML + m_i WML \\ + r_i RERF + e_i. \end{aligned} \tag{12}$$

where the real estate factor, RERF, is the excess return of a value-weighted REIT index in excess of the 1-month Treasury bill yield.

2.3 The Five-Factor Model

The CAPM is widely used in finance to price the anticipated returns for assets given their risk and cost of capital. There are several assumptions behind the CAPM formula that do not hold in reality. Fama and French (1992) emphasize the inability of the CAPM to outline average stock returns, and find that a single factor of excess return on a market portfolio cannot explain for the expected return of a security. In the belief that there are some other factors capable of impacting security price, Fama and French (1997) extend the CAPM by adding size and value risk to the market risk factors. They propose a multifactor model (or the so-called three-factor model) in which the expected return of a security not only depends on its sensitivity to the market returns but also the SMB and HML (size and value respectively) which are two added factors to evaluate the additional risks. SMB represents the returns on a diversified portfolio of small stocks minus those of big stocks, while HML is the difference between the returns on a portfolio of high-book-to-market-equity stocks and those of low-book-to-market-equity stocks.

The return equation of the three-factor model is:

$$E(R_i) = R_f + b_i[E(R_M) - R_f] + s_i E(SMB) + h_i E(HML) \tag{13}$$

where b_i, s_i and h_i are the slopes in the regression:

$$R_i - R_f = a_i + b_i[R_M - R_f] + s_i SMB + h_i HML + e_i \tag{14}$$

In recent years, Fama and French (2015) have modified their model by adding two additional factors. The fourth factor is profitability, which denotes that companies that report higher expected earnings would have higher expected returns in the stock market. The fifth factor is investment, which relates to internal investment and returns in that companies that use their profit in major growth projects are more prone to experience stock market losses.

When profitability and investment are added as factors to the three-factor model which results in the five-factor model, the return equation becomes:

$$R_i - R_f = a_i + b_i\left[R_M - R_f\right] + s_i SMB + h_i HML + r_i RMW + c_i CMA + e_i. \qquad (15)$$

where RMW is the difference between the returns on diversified portfolios of stocks with robust and weak profitability, and CMA is the difference between the returns on diversified portfolios of the stocks of low and high investment firms, which we call conservative and aggressive investments respectively.

3. Data Collection and Sample

We conduct our analysis on a 51 U.S. equity REITs that concern 6 different types of properties: diversified, apartments, timber, health care, retail and offices. This list of 51 equity REITs was obtained from the SNL database of the National Association of Real Estate Investment Trusts (NAREIT) as of December 2014. We chose the REIT sector because both Fama and French (1997) and Cosemans *et al.* (2016) exclude them from their analyses due to the different tax structures.

The firm data (i.e. daily and monthly returns, price and number of shares outstanding for each REIT, the book and market value of equity, the book value of total assets) come from the Center for Research in Security Prices (CRSP) and Compustat. As a proxy for the market portfolio, we use the value-weighted portfolio of all stocks. The sample covers the period from January 1997 to December 2014. We use the market value of equity as a measure of the firm size; ratio between the book value of equity and the market value of equity as the book-to-market value; ratio between the book value of the total assets and market value of equity as financial leverage; and the cumulative return over the 12 months before the current month as the momentum indicator. Finally, the default spread is calculated as the differential yield between Moody's Baa- and Aaa-rated corporate bonds.

To establish our sample, first, we do not consider REITs with a negative book-to-market equity. Then, we not only require that the return on the stock has to be available in the current month *t* and the previous 36 months, but also that its accounting data have to be available in month *t*-1 in order to determine the firm characteristics used in our analysis.

The minimum number of accounting variables required for each firm was available for only 51 of the REITs analyzed in the studied period (that is, January 1997 to December 2014). Some of the companies have merged or dissolved during this period of time, so to avoid survivorship bias, we have eliminated them. In all of the firm characteristics, we trim the outliers to the 0.5^{th} and 99.5^{th} percentile values of their cross-sectional distribution. To prevent all possible issues caused by skewness and remove any trend in average value, we use the logarithmic transformation of the size, book-to-market and financial leverage variables and standardize all firm characteristics by subtracting their cross-sectional mean and then dividing them by the cross-sectional standard deviation in each month.

We formed 10 size decile portfolios of equally-weighted equity REITs (from smallest 2, 3 , 4, … to largest - 9) and on the basis of their current market value, we sorted them into ten groups. Then, by considering the type of property, we group the same REITs into six equally-weighted portfolios by using only 46 of the equity REITs because we remove 5 that are too small to form a portfolio by type.

Finally, we form an equally-weighted portfolio by taking into account all 51 REITs, namely the *ALL REITs* portfolio.

Table 1 reports the summary statistics of the 51 REITs in our sample, which are classified by property focus. The size is represented by the market value, which is obtained as price per share multiplied by the number of shares outstanding. We also include average and standard deviation of returns for each REIT, which are annualized by multiplying by 12. After a careful analysis of the firm returns, we notice that in many cases, there is a wide variation between the average return and the standard deviation: we need to look at CBL & Associates Properties, Inc., which has an average return of 0.242 with the highest standard deviation (2.302), or Macerich with an average return of 0.247 and standard deviation of 1.837. We also show in Table 1 the monthly traded volume (which is expressed in millions of shares). Many of the REITs considered in our sample are widely traded. For instance, the monthly trading volume of Weyerhaeuser Co. is 46.663 million shares with a standard deviation of 40.672. Kimco Realty Corporation has a monthly trading volume of 42.302 million shares and standard deviation of 58.318. However, Income Opportunity Realty Investors, Inc. has the lowest monthly trading volume of just 0.030 million shares and a standard deviation of 0.061. In view of these variations, we winsorize firm returns at the 5% and 95% levels in order to limit extreme values in the data and reduce the effects of outliers.

Panel A of Table 2 reports the summary statistics of 10 size decile portfolios of equally-weighted equity REITs by sorting them on the basis of their market value. From these statistics, we can observe that smaller REITs have lower returns, while larger ones tend to have higher returns.

Table 1 Summary Statistics of Individual REITs

Ticker	REIT Name	Type	Size	Firm Returns		Volume	
				Avg	Std	Avg	Std
CUZ	Cousins Properties Inc.	Diversified	2,473	0.101	0.997	9.641	11.816
VNO	Vornado Realty Trust	Diversified	22,098	0.181	0.918	19.741	25.491
WRE	Washington Real Estate Investment Trust	Diversified	1,844	0.107	0.709	6.158	6.614
IOT	Income Opportunity Realty Investors, Inc.	Diversified	24	0.149	1.637	0.030	0.061
LXP	Lexington Realty Trust	Diversified	2,550	0.143	1.104	12.857	14.298
HIW	Highwoods Properties, Inc.	Diversified	4,041	0.119	0.830	10.425	8.313
UDR	UDR Inc.	Apartments	7,866	0.132	0.828	24.413	23.726
PPS	Post Properties, Inc.	Apartments	3,201	0.119	0.871	8.059	6.910
APT	Camden Property Trust	Apartments	6,380	0.148	0.860	9.052	9.015
SUI	Sun Communities, Inc.	Apartments	2,903	0.154	0.911	2.163	1.573
MAA	Mid-America Apartment Communities, Inc.	Apartments	5,620	0.146	0.722	4.237	4.518
AIV	Apartment Investment & Management Co.	Apartments	5,432	0.164	1.089	20.606	21.852
HME	Home Properties, Inc.	Apartments	3,763	0.157	0.744	6.239	5.310
AEC	Associated Estates Realty Corporation	Apartments	1,338	0.137	1.057	3.312	3.712
ESS	Essex Property Trust, Inc.	Apartments	13,210	0.196	0.758	4.987	5.586
UMH	UMH Properties, Inc.	Apartments	226	0.095	0.767	0.388	0.438
PCH	Potlatch Corp.	Timber	1,700	0.104	0.887	5.061	4.198
WY	Weyerhaeuser Co.	Timber	18,819	0.116	1.031	46.663	40.672
PCL	Plum Creek Timber Co., Inc.	Timber	7,526	0.112	0.756	19.871	22.189
RYN	Rayonier, Inc.	Timber	3,541	0.150	0.860	9.829	9.701
HCN	Welltower Inc.	HealthCare	24,795	0.176	0.774	18.128	20.856

(Continued…)

(Table 1 Continued)

Ticker	REIT Name	Type	Size	Firm Returns Avg	Firm Returns Std	Volume Avg	Volume Std
HCP	HCP, Inc.	HealthCare	20,221	0.148	0.858	31.092	38.217
UHT	Universal Health Realty Income Trust	HealthCare	622	0.146	0.699	0.735	0.480
OHI	Omega Healthcare Investors, Inc.	HealthCare	4,979	0.177	1.426	9.983	10.433
LTC	LTC Properties, Inc.	HealthCare	1,506	0.166	0.949	2.468	1.363
HR	Healthcare Realty Trust	HealthCare	2,682	0.121	0.851	7.760	7.251
NHI	National Health Investors	HealthCare	2,582	0.167	1.012	1.830	1.021
KIM	Kimco Realty Corporation	Retail	10,343	0.153	1.084	42.302	58.318
WRI	Weingarten Realty Investors	Retail	4,270	0.142	1.059	11.804	13.774
OLP	One Liberty Properties, Inc.	Retail	384	0.171	1.151	0.547	0.656
TCO	Taubman Centers, Inc.	Retail	4,839	0.198	0.911	9.105	8.595
DDR	Developers Diversified Realty Corporation	Retail	6,618	0.158	1.393	32.168	39.035
SKT	Tanger Factory Outlet Centers, Inc.	Retail	3,544	0.176	0.723	6.355	7.029
FRT	Federal Realty Investment Trust	Retail	9,093	0.168	0.726	7.408	8.437
ALX	Alexander's Inc.	Retail	2,232	0.166	1.007	0.104	0.090
BFS	Saul Centers, Inc.	Retail	1,195	0.165	0.830	0.802	0.506
CBL	CBL & Associates Pptys, Inc.	Retail	3,307	0.242	2.302	17.453	21.097
REG	Regency Centers Corporation	Retail	5,947	0.160	0.886	9.722	12.053
SPG	Simon Property Group, Inc.	Retail	56,597	0.195	0.889	29.769	38.458
MAC	Macerich Company	Retail	13,174	0.247	1.837	14.770	19.926
ADC	Agree Realty Corp.	Retail	545	0.161	0.957	0.746	0.676
O	Realty Income Corporation	Retail	10,624	0.161	0.672	13.574	16.535

(***Continued…***)

(Table 1 Continued)

Ticker	REIT Name	Type	Size	Firm Returns Avg	Firm Returns Std	Volume Avg	Volume Std
NNN	National Retail Properties	Retail	5,164	0.157	0.747	11.594	12.534
DRE	Duke Realty Corp.	Office	6,903	0.128	1.125	29.300	32.506
BDN	Brandywine Realty Trust	Office	2,860	0.172	1.518	16.460	18.237
CLI	Mack-Cali Realty Corporation	Office	1,697	0.091	0.882	11.548	10.214
PSA	Public Storage	Storage	31,928	0.183	0.771	14.419	17.106
SSS	Sovran Self Storage, Inc.	Storage	2,944	0.158	0.840	2.185	1.683
FR	First Industrial Realty Trust, Inc.	Industrial	2,273	0.137	1.317	9.223	8.385
HPT	Hospitality Properties Trust	Lodging	4,647	0.134	0.942	13.115	14.064
PW	Power REIT	Alt Energy	14	0.077	0.608	0.043	0.039
Ave			42.672	0.152	0.982	11.769	13.050

Notes: Table 1 reports the summary statistics for the 51 equity REITs considered in our sample. The period covered is January 1997 to December 2014. *Type* indicates property focus. *Size* stands for the market value (price per share times number of shares outstanding obtained from the CRSP) of the firm in millions of US dollars as of December 2014. *Firm Returns* denotes the annualized 1-month holding-period-return obtained from the CRSP. Returns are annualized by multiplying by 12. *Volume* is the monthly trading volume in millions of shares. *Ave* and *Std* stand for average and standard deviations respectively.

Table 2 Summary Statistics of REIT Portfolios

Panel A: Size Decile of REIT Portfolios

Decile of REIT Portfolio	Size	Return		Volume	
		Avg	Std	Avg	Std
Smallest	162	0.091	0.587	0.518	0.708
2	1,041	0.160	0.871	3.486	5.793
3	1,747	0.171	0.901	5.434	7.819
4	2,465	0.112	0.705	8.674	9.855
5	3,186	0.153	0.691	9.437	10.042
6	4,025	0.169	0.786	11.361	12.474
7	5,113	0.151	0.767	15.073	17.808
8	6,873	0.165	0.706	14.243	15.332
9	11,289	0.159	0.673	22.025	25.210
Largest	29,077	0.175	0.712	28.358	26.537

Panel B: Type REIT Portfolios

REIT Type Portfolio	Size	Return		Volume	
		Avg	Std	Avg	Std
Diversified (6)	5,504	0.124	0.716	10.316	9.725
Apartments (10)	4,993	0.136	0.695	8.758	7.613
Timber (4)	7,896	0.118	0.760	21.283	15.838
HealthCare (7)	8,198	0.152	0.719	10.816	10.935
Retail (16)	8,617	0.170	0.864	13.680	15.163
Office (3)	3,819	0.110	1.110	20.093	19.928
All REITs	7,119	0.144	0.698	12.358	11.763

Notes: Table 2 reports the summary statistics for both the decile of the REIT portfolios and REIT type portfolios.

Panel A shows the summary statistics of the decile of the REIT portfolios. At the beginning of each year, we form the size deciles of equally-weighted equity REIT portfolios by sorting them in ten groups depending on their market value (price per share times number of shares outstanding obtained from the CRSP). Panel B presents the summary statistics of REIT type portfolios. We group the firms in six equally-weighted portfolios by property focus with 46 equity REITs out of the 51 in the original sample. We remove PSA, SSS, FR, HPT and PW because there are too few to form a significant portfolio by type. We also form an equally-weighted portfolio based on all 51 REITs which is called *ALL REITs*.

Size is the equally-weighted portfolio market value as of December 2014 in millions of US dollars. *Firm Returns* are the annualized 1-month holding-period-returns of the equally-weighted portfolio. Returns are annualized by multiplying by 12. *Volume* is the monthly trading volume of the equally-weighted portfolio in millions of shares. *Ave* and *Std* stand for average and standard deviations respectively.

Panel B of Table 2 reports the summary statistics of 6 equally-weighted portfolios grouped by REIT property type. The average returns in our sample portfolios range from 0.110 to 0.170, while the annualized returns of All REITs is 0.144. Furthermore, the standard deviation for the All REITs portfolio is always less than that of the property type portfolios. The annual standard deviation of our portfolios ranges from 0.695 for apartments to 1.110 for offices, while the All REITs portfolio has a standard deviation of 0.693 each year. With regard to this last aspect, it should be emphasized that the All REITs portfolio is composed of a larger number of firms and this might have contributed to a lower standard deviation.

4. Estimating Forecasting Accuracy

In this section, we compare the "hybrid beta" model with the four-factor, REIT-factor, and five-factor models in a way that should enable managers to estimate reliable factor loadings. To highlight the direct evidence on the merits of the hybrid beta approach, we match its out-of-sample forecasting ability with that of the competing estimation technique mentioned earlier. That is, we compare the risk loadings estimated via the "hybrid beta" model with both rolling and full-sample OLS regressions of the other three models.

If we consider near-term cash flows, the current level of risk is better captured by using a rolling regression. However, if we are focusing on distant cash-flows, we cannot ignore the behavior of the true risk loadings. Since we do not know the nature of the true process that produces the factor loadings, we consider that the process could be one that is mean-reverting or a random walk. If the process is mean-reverting, better estimates can be provided by using a full-sample regression because the average in the long term should be the best unbiased forecast of the next observation. However, if the process is a random walk, the best estimation of the next observation is obtained by considering its recent value and so, with a rolling regression because these estimates are weighted with the current information.

In our analysis, we compare the forecasting ability of the "hybrid beta" model with that of the four-factor, REIT-factor, and five-factor models by using two different approaches. On the one hand, we run a full-sample OLS regression. On the other hand, we run 1-year, 3-year and 5-year rolling window OLS regressions. To evaluate the predictive ability of these models, we consider both near and more distant forecast horizons and, precisely, we compare the 1-month, 1-year, 3-year and 5-year out-of-sample forecasting accuracy of each estimation method applied.

We expect that hybrid beta estimates should outperform the four-factor, REIT-factor, and five-factor model estimates at both the near and distant horizons because the hybrid beta approach combines the qualities of both rolling and full-sample regressions by incorporating prior information based on firm fundamentals.

4.1 Forecast Error- Comparison: Hybrid-Beta Model vs. Four-Factor Model

We first compare the forecast errors produced by the cost of equity estimates associated with the hybrid beta model with those obtained by using the Carhart four-factor model via rolling and full-sample OLS regressions.

We obtain the 1-month, 1-year, 3-year, and 5-year time series of the absolute forecast errors with factor loadings estimated by using full-sample OLS regressions and 1-year, 3-year, and 5-year rolling regressions from January 1997 to December 2014.

The times series of the 1-month forecast errors for the hybrid beta model and the full-sample OLS regression with the four-factor model are calculated as the monthly difference between the realized excess return on month $t+1$ for REIT (portfolio) i and the cost of equity estimate provided by the two models on the same month for the same REIT (portfolio) i.

The 1-month time series of the forecasting error for the four-factor model is obtained as:

$$\varepsilon(1)_{t+1} = R_{t+1,i} - \hat{R}_{t+1,i}, \tag{16}$$

that is, the difference between the realized annualized cost of equity for REIT (portfolio) i on month $t+1$, $R_{t+1,i}$, and the cost of equity estimate, $\hat{R}_{t+1,i}$, is given by:

$$\begin{aligned} \hat{R}_{t+1,i} = \bar{R}_f + b_{t,i}\left(\bar{R}_M - \bar{R}_f\right) + c_{t,i}(\overline{SMB}) \\ +d_{t,i}(\overline{HML}), + h_{t,i}(\overline{WML}) \end{aligned} \tag{17}$$

where $b_{t,i}$ is the factor loading on the market factor at time t for firm i, $c_{t,i}$ is the loading on SMB, $d_{t,i}$ is the factor loading on HML and $h_{t,i}$ is the factor loading on WML. $\left(\bar{R}_M - \bar{R}_f\right)$, $\overline{SMB}$, $\overline{HML}$, and $\overline{WML}$ represent the long run average of the market premium risk, risk free rate, SMB, HML, and WML, respectively. Using this process, we obtain the monthly time series of the forecast errors for the 1-, 3- and 5-year rolling regressions. Finally, we obtain the time series of the τ-year absolute forecast errors as:

$$\varepsilon\, abs(\tau)_{t+1} = \left|\sum_{j=1}^{\tau} \varepsilon(1)_{t+1-j,i}\right|, \tag{18}$$

where τ is equal to 12, 36 and 60 for the 1-, 3- and 5-year forecast horizons, respectively. By applying Equation (18), we obtain the monthly time series of the absolute forecast errors for the different forecast horizons.

The mean absolute forecast errors of the REITs are reported in the first row of Table 3. At the 1-month forecast horizon, there appears to be no difference in accuracy between the cost of equity estimated via a rolling or full sample OLS regression. In fact, the results show that on average for the 1-month forecasts, the hybrid beta approach and the four-factor model have the same absolute forecast error of 0.058.

Table 3 Mean and Standard Deviations of Absolute Forecast Errors for REITs with Four-Factor and Hybrid Beta Models

	Estimation method: 1 yr rolling OLS regression				Estimation method: 3 yr rolling OLS regression			
	Forecast horizon:				Forecast horizon:			
Ave	1 mo	1 yr	3 yr	5 yr	1 mo	1 yr	3 yr	5 yr
Mean	0.058	0.662	1.901	3.007	0.058	0.660	1.895	2.995
Standard Deviation	0.063	0.392	0.975	1.525	0.063	0.388	0.964	1.516
	Estimation method: 5 yr rolling OLS regression				Estimation method: Full sample OLS regression			
	Forecast horizon:				Forecast horizon:			
Ave	1 mo	1 yr	3 yr	5 yr	1 mo	1 yr	3 yr	5yr
Mean	0.058	0.662	1.898	2.998	0.058	0.669	1.921	3.037
Standard Deviation	0.063	0.387	0.964	1.518	0.063	0.376	0.925	1.456
	Estimation method: hybrid beta method							
	Forecast horizon:							
Ave	1 mo	1 yr	3 yr	5yr				
Mean	0.058	0.276	0.708	1.119				
Standard Deviation	0.064	0.276	0.546	0.705				

***Notes*:** Table 3 reports the mean and standard deviations of the absolute forecast errors by using the four-factor and the hybrid beta models as cost of equity capital models for REITs. The period covered is January 1997 to December 2014. We compare the hybrid beta model to 4 four-factor models as an estimation method for: 1-year , 3-year, and 5-year rolling window and full sample OLS regressions. After we obtain the factor loadings for each firm with both the four-factor (rolling and full sample regressions) and the hybrid beta models, we calculate the cost of equity capital estimates by using the long run average of market premium risk, risk-free rate, SMB, HML and WML. The monthly forecast errors are obtained as the difference between the 1-month ahead realized return and the estimated cost of equity capital based on our four-factor model. Given the monthly time series of the forecast errors, we obtain the absolute forecast errors for the 1-month, 1-year, 3-year and 5-year horizons. *Ave* indicates the average of the absolute forecast errors for all of the REITs.

Continuing our analysis, we find that the choice of estimation method influences the accuracy of more distant discount rates. For all of the other forecast periods that we consider, as cash flows become more distant, the recommended estimation method is the hybrid beta model, which provides more accuracy than the four-factor model. In particular, we obtain an absolute forecast error of 0.276, 0.708, and 1.119 for the 1-year, 3-year, and 5-year horizons, which are more than 50% lower than those associated with the four-factor estimates.

In the second row of Table 3, we present the standard deviations of the mean absolute forecast errors. For the 1-month forecast horizon, a manager can be almost indifferent between using the hybrid beta approach and the four-factor model (rolling and full sample OLS regressions). However, for more distant forecasts, the hybrid beta estimates are always associated with lower standard deviations: 0.276 for the 1-year horizon, 0.546 for the 3-year horizon, and 0.705 for the 5-year horizon.

Table 4 shows the mean and standard deviations of the absolute errors at the size decile level. In the first row, the differences between the hybrid beta and four-factor models at the 1-month horizon are not so obvious: 0.045 for the 1-year, 3-year, and 5-year rolling and full-sample OLS regressions, and 0.044 for the hybrid beta model. When we have to discount longer term cash flows, the choice of the estimation method has a greater effect. In particular, the hybrid beta approach produces the fewest forecast errors and its accuracy, compared to the rolling and full-sample OLS regressions with the four-factor model, increases with longer horizons. In the second row, the standard deviation is reported for each size portfolio. Once again, the lowest level of dispersion is associated with the hybrid beta approach both for rolling and full-sample OLS regressions.

Panels A and B of Table 5 contain the mean and standard deviations of the absolute forecast errors for the type portfolios and the All REITs portfolio, respectively. At the level of the type portfolio, the hybrid beta model proves to have a better performance. In fact, the results are broadly consistent across property type groupings and the good predictive ability of this model is therefore validated.

This trend also holds if we focus on the mean and standard deviations of the All REITs portfolio. Even though the differences between the rolling and full-sample OLS regressions are not significant, they are always greater than those obtained with the hybrid beta-model.

Overall, our results show that for both the near and long-term horizons, the hybrid beta model provides more accurate estimates of the cost of equity when compared to the four-factor model at all three- levels of the analysis.

Table 4 Mean and Standard Deviations of Absolute Forecast Errors for Size Decile of Portfolios of REITs with Four-Factor and Hybrid Beta Models

	Estimation method: 1 yr rolling OLS regression				Estimation method: 3 yr rolling OLS regression			
	Forecast horizon:				Forecast horizon:			
Ave	1 mo	1 yr	3 yr	5 yr	1 mo	1 yr	3 yr	5 yr
Mean	0.045	0.512	1.473	2.326	0.045	0.514	1.476	2.328
Standard Deviation	0.048	0.322	0.792	1.240	0.048	0.318	0.786	1.240
	Estimation method: 5 yr rolling OLS regression				Estimation method: Full sample OLS regression			
	Forecast horizon:				Forecast horizon:			
Ave	1 mo	1 yr	3 yr	5 yr	1 mo	1 yr	3 yr	5yr
Mean	0.045	0.516	1.480	2.334	0.045	0.519	1.491	2.353
Standard Deviation	0.048	0.318	0.786	1.241	0.048	0.310	0.761	1.201
	Estimation method: hybrid beta method							
	Forecast horizon:							
Ave	1 mo	1 yr	3 yr	5yr				
Mean	0.044	0.168	0.309	1.383				
Standard Deviation	0.047	0.161	0.234	0.280				

Notes: Table 4 reports the mean and standard deviations of the absolute forecast errors by using the four-factor and the hybrid beta models as cost of equity capital models for size decile of the portfolios of REITs. The period covered is January 1997 to December 2014. We obtain the 10 size decile portfolios of equally-weighted equity REITs by grouping REITs each year by size. We compare the hybrid beta model to 4 four-factor estimation methods: 1-year, 3-year and 5-year rolling window and full sample OLS regressions. After we obtain the factor loadings for each firm with both the four-factor model (rolling and full sample regressions) and the hybrid beta models, we calculate the cost of equity capital estimates by using the long run average of market premium risk, risk-free rate, SMB, HML and WML. The monthly forecast errors are obtained as the difference between the 1-month ahead realized return and the estimated cost of equity capital based on our four-factor and hybrid beta models. Given the monthly time series of the forecast errors, we obtain the absolute forecast errors for the 1-month, 1-year, 3-year and 5-year horizons. *Ave* indicates the average of the absolute forecast errors for all REITs.

Table 5 Mean and Standard Deviations of Absolute Forecast Errors for Type Portfolios of REITs with Four-Factor and Hybrid Beta Models

Panel A: Mean of Absolute Forecast Errors

	Estimation method: 1 yr rolling OLS regression				Estimation method: 3 yr rolling OLS regression			
	Forecast horizon:				Forecast horizon:			
Ave	1 mo	1 yr	3 yr	5 yr	1 mo	1 yr	3 yr	5 yr
Mean	0.048	0.540	1.552	2.449	0.048	0.541	1.553	2.448
All REITs	0.042	0.466	1.34	2.115	0.042	0.469	1.345	2.121
	Estimation method: 5 yr rolling OLS regression				Estimation method: Full sample OLS regression			
	Forecast horizon:				Forecast horizon:			
Ave	1 mo	1 yr	3 yr	5 yr	1 mo	1 yr	3 yr	5yr
Mean	0.048	0.542	1.556	2.452	0.048	0.548	1.572	2.480
All REITs	0.042	0.47	1.348	2.125	0.042	0.472	1.355	2.137
	Estimation method: hybrid beta method							
	Forecast horizon:							
Ave	1 mo	1 yr	3 yr	5yr				
Mean	0.048	0.261	0.692	1.086				
All REITs	0.042	0.261	0.726	1.174				

Panel B: Standard Deviation of Absolute Forecast Errors

	Estimation method: 1 yr rolling OLS regression				Estimation method: 3 yr rolling OLS regression			
	Forecast horizon:				Forecast horizon:			
Ave	1 mo	1 yr	3 yr	5 yr	1 mo	1 yr	3 yr	5 yr
Mean	0.052	0.331	0.816	1.284	0.052	0.326	0.807	1.278
All REITs	0.050	0.305	0.757	1.188	0.050	0.30	0.749	1.182
	Estimation method: 5 yr rolling OLS regression				Estimation method: Full sample OLS regression			
	Forecast horizon:				Forecast horizon:			
Ave	1 mo	1 yr	3 yr	5 yr	1 mo	1 yr	3 yr	5yr
Mean	0.052	0.326	0.808	1.281	0.052	0.317	0.779	1.234
All REITs	0.050	0.301	0.75	1.185	0.050	0.295	0.731	1.154
	Estimation method: hybrid beta method							
	Forecast horizon:							
Ave	1 mo	1 yr	3 yr	5yr				
Mean	0.052	0.216	0.385	0.495				
All REITs	0.050	0.255	0.591	0.857				

Notes: Table 5 reports the mean and standard deviation of the absolute forecast errors by using the four-factor and the hybrid beta models as cost of equity capital models for type portfolios of REITs. The period covered is January 1997 to December 2014. We compare the hybrid beta model to 4 four-factor model estimation methods: 1-year, 3-year, and 5-year rolling window and full sample OLS regressions. After we obtain factor loadings for each firm with both the four-factor (rolling and full sample regressions) and the hybrid beta models, we calculate the cost of equity capital estimated by using the long run average of market premium risk, risk-free rate, SMB, HML and WML. The monthly forecast errors are obtained as the difference between the 1-month ahead realized returns and the cost of equity capital estimates based on our four-factor model. Given the monthly time series of the forecast errors, we obtain absolute forecast errors for the 1-month, 1-year, 3-year and 5-year horizons. *Ave* indicates the average of the absolute forecast errors for all REITs.

4.2 Forecast Error Comparison: Hybrid-Beta Model vs. REIT-Factor Model

We examine the forecasting ability of the REIT-factor model in Chen *et al.* (2012) by comparing the model to the hybrid beta model. As for the previous models, we extract the 1-month time series of the absolute forecast errors for the full-sample OLS regression for each REIT with the REIT-factor model as the monthly difference between the realized excess return and the cost of equity estimate provided by the model on the same month. We also run rolling regressions with 1-year, 3-year, and 5-year rolling windows, in order to obtain a monthly time series of risk factor loadings. The monthly series of forecast errors is given by:

$$\begin{aligned}\hat{R}_{t+1,i} = \bar{R}_f + b_{t,i}\left(\bar{R}_M - \bar{R}_f\right) + c_{t,i}(\overline{SMB}) + d_{t,i}(\overline{HML}) \\ + h_{t,i}(\overline{WML}) + r_{t,i}(\overline{RERF})\end{aligned} \tag{19}$$

where $b_{t,i}$, $c_{t,i}$, $h_{t,i}$, and $d_{t,i}$ are the factor loadings estimated via rolling regressions on the market factor, SMB, HML and WML, respectively, which was also the case with the four-factor model,. In addition, $r_{t,i}$ represents the factor loadings on RERF in this model.

The first row of Table 6 shows the mean absolute forecast errors for the REITs. On average, the different estimation methods show no significant differences (0.057 for the 1-, 3-, 5-year rolling and full sample OLS regressions, and 0.058 for the hybrid beta model) at the 1-month horizon. For the long-term horizon, the hybrid beta model on average has the lowest absolute forecast error, that is, 0.276 for the 1-year, 0.708 for the 3-year and 1.119 for the 5-year forecast horizons. These results show that in calculating the appropriate discount rate for the valuation of distant cash flows, the choice of estimation model appears to play a key role.

In the second row of Table 7, we report the standard deviations of the absolute forecast errors. At the 1-month horizon, the full-sample regression with the REIT-factor model has the lowest level of dispersion of 0.063, even though the differences between the rolling regression with the REIT-factor and hybrid beta models are not obvious; that is, 0.064 for the 1-, 3-, 5 year rolling regression models as well as the hybrid beta model. Again, the choice of estimation method has a greater effect when we have to discount longer term cash flows. The hybrid beta model, once again, produces the lowest forecast errors, and its accuracy relative to the rolling and full-sample OLS regressions with the REIT-factor model increases with longer horizons. In particular, the absolute forecast errors associated with the estimates of the REIT-factor model are 0.276, 0.546 and 0.705 for the 1-year, 3-year, and 5-year horizons respectively.

Table 6 Mean and Standard Deviation of Absolute Forecast Errors for REITs with REIT-Factor and Hybrid Beta Models

	Estimation method: 1 yr rolling OLS regression				Estimation method: 3 yr rolling OLS regression			
	Forecast horizon:				Forecast horizon:			
Ave	1 mo	1 yr	3 yr	5 yr	1 mo	1 yr	3 yr	5 yr
Mean	0.057	0.652	1.872	2.959	0.057	0.648	1.859	2.939
Standard Deviation	0.064	0.395	0.977	1.522	0.064	0.392	0.972	1.516
	Estimation method: 5 yr rolling OLS regression				Estimation method: Full sample OLS regression			
	Forecast horizon:				Forecast horizon:			
Ave	1 mo	1 yr	3 yr	5 yr	1 mo	1 yr	3 yr	5yr
Mean	0.057	0.648	1.860	2.939	0.057	0.659	1.893	2.994
Standard Deviation	0.064	0.392	0.972	1.517	0.063	0.378	0.927	1.449
	Estimation method: hybrid beta method							
	Forecast horizon:							
Ave	1 mo	1 yr	3 yr	5yr				
Mean	0.058	0.276	0.708	1.119				
Standard Deviation	0.064	0.276	0.546	0.705				

***Notes*:** Table 6 reports the mean and standard deviations of the absolute forecast errors by using the REIT-factor and the hybrid beta models as cost of equity capital models for REITs. The period covered is January 1997 to December 2014. We compare the hybrid beta model to 4 REIT factor model estimation methods: 1-year, 3-year and 5-year rolling window and full sample OLS regressions. After we obtain the factor loadings for each firm with both the REIT factor (rolling and full sample regressions) and the hybrid beta models, we calculate the cost of equity capital estimates by using the long run average of market premium risk, risk-free rate, SMB, HML, WML and RERF. The monthly forecast errors are obtained as the difference between the 1-month ahead realized return and the cost of equity capital estimates based on our REIT factor model. Given the monthly time series of forecast errors, we obtain absolute forecast errors for the 1-month, 1-year, 3-year and 5-year horizons. *Ave* indicates the average of absolute forecast errors for all REITs.

In Table 8, we report the mean and standard deviations of the absolute forecast errors at the level of the size decile of the portfolio in the first and second rows, respectively. It is obvious that with longer horizons, the performance of the hybrid beta approach is always better in comparison to the REIT factor model for the 1-year horizon, in which the mean absolute forecast error is 0.168, the 3-year horizon, which is 0.309 and the 5-year horizon, which is 0.383. As mentioned above, the better predictive ability of the hybrid beta method is also confirmed when we analyze the levels of standard deviation for longer term forecasts: 0.161 for 1-year horizon, 0.234 for 3-year horizon and 0.280 for 5-year horizon.

As for the previous analysis, the trend is validated when we present the mean and standard deviation of the absolute forecast errors for the type portfolio. Focusing on longer term horizons, the hybrid beta model produces cost of equity estimates more accurately for both rolling and full-sample OLS regressions and its forecast errors have a lower level of dispersion than those produced by the REIT-factor model. We notice similar results after analyzing the mean and standard deviation of the All REITs portfolio.

4.3 Forecast Error Comparison: Hybrid Beta Model vs. Five-Factor Model

Finally, we compare the forecasting ability of the five-factor model of Fama and French (2015) with that of the hybrid beta model. To extract the 1-month, 1-year, 3-year and 5-year time-series of the absolute forecast errors, we use the same method as we had used in the previous sections, with the risk factors estimated by using 1-year, 3-year and 5-year rolling regressions. The monthly series of the forecast errors is given by:

$$\begin{aligned}\hat{R}_{t+1,i} = \bar{R}_f + b_{t,i}\left(\bar{R}_M - \bar{R}_f\right) + s_{t,i}(\overline{SMB}) + d_{t,i}(\overline{HML}) \\ + r_{t,i}(\overline{RMW}) + c_{t,i}(\overline{CMA})\end{aligned} \tag{20}$$

where $b_{t,i}$, $s_{t,i}$, $d_{t,i}, r_{t,i}$ and $c_{t,i}$ are the factor loadings estimated via a rolling regression on the market factor, SMB, HML, RMW and CMA respectively, at time t for REIT (portfolio) i. $\left(\bar{R}_M - \bar{R}_f\right)$, $\bar{R}_f$, $\overline{SMB}$,$\overline{HML}$, $\overline{RMW}$ and $\overline{CMA}$ are the long run average of the market premium risk, risk-free rate, SMB, HML, RMW and CMA factors, respectively. As for the hybrid beta model, we use the same time series of the absolute forecast errors shown in the comparison with the other models.

Table 9 reports the mean and standard deviations of the absolute forecast errors for the REITs.

Table 7 Mean and Standard Deviations of Absolute Forecast Errors for Size Deciles Portfolios of REITs with REIT-Factor and Hybrid Beta Models

	Estimation method: 1 yr rolling OLS regression				Estimation method: 3 yr rolling OLS regression			
	Forecast horizon:				Forecast horizon:			
Ave	1 mo	1 yr	3 yr	5 yr	1 mo	1 yr	3 yr	5 yr
Mean	0.044	0.505	1.450	2.287	0.044	0.504	1.448	2.285
Standard Deviation	0.048	0.322	0.789	1.228	0.048	0.321	0.790	1.234

	Estimation method: 5 yr rolling OLS regression				Estimation method: Full sample OLS regression			
	Forecast horizon:				Forecast horizon:			
Ave	1 mo	1 yr	3 yr	5 yr	1 mo	1 yr	3 yr	5yr
Mean	0.044	0.505	1.449	2.286	0.044	0.512	1.471	2.323
Standard Deviation	0.048	0.321	0.790	1.235	0.048	0.311	0.757	1.183

	Estimation method: hybrid beta method			
	Forecast horizon:			
Ave	1 mo	1 yr	3 yr	5yr
Mean	0.044	0.168	0.309	0.383
Standard Deviation	0.047	0.161	0.234	0.280

Notes: Table 7 reports the mean and standard deviations of the absolute forecast errors by using the REIT-factor and the hybrid beta models as cost of equity capital models for the size decile of the portfolios of REITs. The period covered is January 1997 to December 2014. We obtain the 10 size decile portfolios of equally-weighted equity REITs by grouping the REITs by size each year. We compare the hybrid beta model to 4 REIT-factor estimation methods: 1-year, 3-year, and 5-year rolling window and full sample OLS regressions. After we obtain the factor loadings for each firm with both the REIT-factor (rolling and full sample regressions) and the hybrid beta models, we calculate the cost of equity capital estimates by using the long run average of market premium risk, risk-free rate, SMB, HML, WML and RERF. The monthly forecast errors are obtained as the difference between the 1-month ahead realized return and the cost of equity capital estimates based on our REIT-factor and hybrid beta models. Given the monthly time series of the forecast errors, we obtain absolute forecast errors for the 1-month, 1-year, 3-year and 5-year horizons. *Ave* indicates the average of absolute forecast errors for all REITs.

Table 8 Mean and Standard Deviations of Absolute Forecast Errors for Type Portfolios of REITs with REIT-Factor and Hybrid Beta Models

Panel A: Mean of Absolute Forecast Errors

	Estimation method: 1 yr rolling OLS regression				Estimation method: 3 yr rolling OLS regression			
	Forecast horizon:				Forecast horizon:			
Ave	1 mo	1 yr	3 yr	5 yr	1 mo	1 yr	3 yr	5 yr
Mean	0.048	0.531	1.527	2.407	0.048	0.531	1.527	2.407
All REITs	0.042	0.456	1.307	2.061	0.042	0.457	1.311	2.067
	Estimation method: 5 yr rolling OLS regression				Estimation method: Full sample OLS regression			
	Forecast horizon:				Forecast horizon:			
Ave	1 mo	1 yr	3 yr	5 yr	1 mo	1 yr	3 yr	5yr
Mean	0.048	0.532	1.529	2.409	0.048	0.542	1.557	2.457
All REITs	0.042	0.457	1.312	2.069	0.042	0.463	1.33	2.098
	Estimation method: hybrid beta method							
	Forecast horizon:							
Ave	1 mo	1 yr	3 yr	5yr				
Mean	0.048	0.261	0.692	1.086				
All REITs	0.042	0.261	0.726	1.174				

Panel B: Standard Deviation of Absolute Forecast Errors

	Estimation method: 1 yr rolling OLS regression				Estimation method: 3 yr rolling OLS regression			
	Forecast horizon:				Forecast horizon:			
Ave	1 mo	1 yr	3 yr	5 yr	1 mo	1 yr	3 yr	5 yr
Mean	0.052	0.331	0.815	1.279	0.052	0.330	0.815	1.280
All REITs	0.050	0.302	0.747	1.165	0.050	0.302	0.749	1.172
	Estimation method: 5 yr rolling OLS regression				Estimation method: Full sample OLS regression			
	Forecast horizon:				Forecast horizon:			
Ave	1 mo	1 yr	3 yr	5 yr	1 mo	1 yr	3 yr	5yr
Mean	0.052	0.330	0.815	1.281	0.052	0.318	0.779	1.226
All REITs	0.050	0.302	0.749	1.174	0.050	0.294	0.722	1.13
	Estimation method: hybrid beta method							
	Forecast horizon:							
Ave	1 mo	1 yr	3 yr	5yr				
Mean	0.052	0.216	0.385	0.495				
All REITs	0.050	0.255	0.591	0.857				

Notes: Table 8 reports the mean and standard deviations of the absolute forecast errors by using the REIT-factor and the hybrid beta models as cost of equity capital models for type portfolios of REITs. The period covered is January 1997 to

December 2014. We compare the hybrid beta model to 4 REIT-factor model estimation methods: 1-year, 3-year, and 5-year rolling window and full sample OLS regressions. After we obtain the factor loadings for each firm with both the REIT-factor (rolling and full sample regressions) and the hybrid beta models, we calculate the cost of equity capital estimates by using the long run average of market premium risk, risk-free rate, SMB, HML, WML and RERF. The monthly forecast errors are obtained as the difference between the 1-month ahead realized return and the cost of equity capital estimates based on our REIT-factor model. Given the monthly time series of the forecast errors, we obtain the absolute forecast errors for the 1-month, 1-year, 3-year and 5-year horizons. *Ave* indicates the average of the absolute forecast errors for all REITs.

Table 9 Mean and Standard Deviation of Absolute Forecast Errors for REITs with Five-Factor and Hybrid Beta Models

	Estimation method: 1 yr rolling OLS regression				Estimation method: 3 yr rolling OLS regression			
	Forecast horizon:				Forecast horizon:			
Ave	1 mo	1 yr	3 yr	5 yr	1 mo	1 yr	3 yr	5 yr
Mean	0.061	0.691	1.984	3.138	0.058	0.668	1.917	3.032
Standard Deviation	0.064	0.403	0.998	1.577	0.064	0.391	0.979	1.543
	Estimation method: 5 yr rolling OLS regression				Estimation method: Full sample OLS regression			
	Forecast horizon:				Forecast horizon:			
Ave	1 mo	1 yr	3 yr	5 yr	1 mo	1 yr	3 yr	5yr
Mean	0.058	0.662	1.901	3.003	0.058	0.665	1.910	3.020
Standard Deviation	0.064	0.391	0.972	1.527	0.064	0.377	0.926	1.453
	Estimation method: hybrid beta method							
	Forecast horizon:							
Ave	1 mo	1 yr	3 yr	5yr				
Mean	0.058	0.276	0.708	1.119				
Standard Deviation	0.064	0.276	0.546	0.705				

Notes: Table 9 reports the mean and standard deviations of the absolute forecast errors by using the five-factor and the hybrid beta models as cost of equity capital models for REITs. The period covered is January 1997 to December 2014. We compare the hybrid beta model to 4 five-factor model estimation methods: 1-year, 3-year, and 5-year rolling window and full sample OLS regressions. After we obtain the factor loadings for each firm with both the five-factor (rolling and full sample regressions) and the hybrid beta models, we calculate the cost of equity capital estimates by using the long run average of market premium risk, risk-free rate, SMB, HML, RMW and CMA. The monthly forecast errors are obtained as the difference between the 1-month ahead realized return and the cost of equity capital estimates based on our five-factor model. Given the monthly time series of the forecast errors, we obtain absolute forecast errors for the 1-month, 1-year, 3-year and 5-year horizons. *Ave* indicates the average of absolute forecast errors for all REITs.

The results show that on average, the hybrid beta approach has a lower absolute forecast error for longer horizons, while the rolling and full-sample OLS regressions with the five-factor model yield more inaccurate estimates. That is, the performance of the hybrid beta model is far superior to that of the five-factor model for all of the forecast periods that are considered here. In fact, we notice that the absolute forecast error for the 1-year, 3-year, and 5-year horizons are always lower than those associated with the five-factor method. The standard deviations of the mean absolute forecast errors for each REIT are presented in the second row of Table 9. At the 1-month horizon, the lowest dispersion value of 0.064 is found with both the hybrid beta and the five-factor models. For longer horizons, the full-sample OLS regression estimates are always associated with lower levels of standard deviation when compared to the rolling regression estimates: 0.377 for the 1-year horizon, 0.926 for the 3-year horizon and 1.453 for the 5-year horizon, but those obtained with the hybrid beta approach (0.276, 0.546 and 0.705 respectively for the 1-year, 3-year and 5-year forecasts), are still the lowest.

By analyzing the mean of the absolute forecast errors for estimates at the level of the size decile of the portfolio in the first row of Table 10, the results show that the predictive power of the hybrid beta model is considerably higher for the 1-month forecast than both the rolling and full-sample OLS regressions. In fact, the hybrid beta model estimate has a mean absolute forecast error of 0.044, while the estimates produced by the 1-year, 3-year, and 5-year rolling and full-sample OLS regressions are 0.047, 0.046, 0.045 and 0.045 respectively. At longer horizons, the performance of the hybrid beta model is much more superior than the other models: the mean absolute forecast errors are 0.168, 0.309 and 0.383 for the 1-year, 3-year and 5-year horizons respectively.

The lowest dispersion value for the short-term forecasts is shown in the second row of Table 10. Once again, the lowest dispersion value of 0.047 is found with the hybrid beta model. The lowest levels of the standard deviation are also found for longer term forecasts: 0.161 for the 1-year horizon, 0.234 for the 3-year horizon and 0.280 for the 5-year horizon.

This trend is also valid if we consider the mean and standard deviations of the absolute forecast errors for the all type portfolios and All REITs portfolios in Table 11.

Table 10 Mean and Standard Deviations of Absolute Forecast Errors for Size Decile of Portfolios of REITs with Five-Factor and Hybrid Beta Models

	Estimation method: 1 yr rolling OLS regression				Estimation method: 3 yr rolling OLS regression			
	Forecast horizon:				Forecast horizon:			
Ave	1 mo	1 yr	3 yr	5 yr	1 mo	1 yr	3 yr	5 yr
Mean	0.047	0.534	1.534	2.426	0.046	0.520	1.493	2.357
Standard Deviation	0.049	0.324	0.789	1.248	0.048	0.319	0.792	1.253
	Estimation method: 5 yr rolling OLS regression				Estimation method: Full sample OLS regression			
	Forecast horizon:				Forecast horizon:			
Ave	1 mo	1 yr	3 yr	5 yr	1 mo	1 yr	3 yr	5yr
Mean	0.045	0.516	1.482	2.338	0.045	0.516	1.481	2.338
Standard Deviation	0.048	0.320	0.792	1.245	0.048	0.311	0.760	1.194
	Estimation method: hybrid beta method							
	Forecast horizon:							
Ave	1 mo	1 yr	3 yr	5yr				
Mean	0.044	0.168	0.309	0.383				
Standard Deviation	0.047	0.161	0.234	0.280				

Notes: Table 10 reports the mean and standard deviations of the absolute forecast errors by using the five-factor and the hybrid beta models as cost of equity capital models for size decile of the portfolios of REITs. The period covered is January 1997 to December 2014. We obtain the 10 size decile portfolios by grouping REITs by size each year. We compare the hybrid beta model to 4 five-factor estimation methods: 1-year, 3-year, and 5-year rolling window and full sample OLS regressions. After we obtain factor loadings for each firm with both the five-factor (rolling and full sample regressions) and the hybrid beta models, we calculate the cost of equity capital estimates by using the long run average of market premium risk, risk-free rate, SMB, HML, RMW and CMA. The monthly forecast errors are obtained as the difference between the 1-month ahead realized return and the cost of equity capital estimates based on our five-factor and hybrid beta models. Given the monthly time series of the forecast errors, we obtain the absolute forecast errors for the 1-month, 1-year, 3-year and 5-year horizons. *Ave* indicates the average of absolute forecast errors for all REITs.

Table 11 Mean and Standard Deviations of Absolute Forecast Errors for Type Portfolios of REITs with Five-Factor and Hybrid Beta Models

Panel A: Mean of Absolute Forecast Errors

	Estimation method: 1 yr rolling OLS regression				Estimation method: 3 yr rolling OLS regression			
	Forecast horizon:				Forecast horizon:			
Ave	1 mo	1 yr	3 yr	5 yr	1 mo	1 yr	3 yr	5 yr
Mean	0.049	0.560	1.607	2.537	0.048	0.546	1.568	2.472
All REITs	0.043	0.488	1.401	2.215	0.042	0.475	1.365	2.154

	Estimation method: 5 yr rolling OLS regression				Estimation method: Full sample OLS regression			
	Forecast horizon:				Forecast horizon:			
Ave	1 mo	1 yr	3 yr	5 yr	1 mo	1 yr	3 yr	5yr
Mean	0.048	0.542	1.558	2.455	0.048	0.545	1.565	2.468
All REITs	0.042	0.471	1.352	2.132	0.042	0.469	1.345	2.121

	Estimation method: hybrid beta method			
	Forecast horizon:			
Ave	1 mo	1 yr	3 yr	5yr
Mean	0.048	0.261	0.692	1.086
All REITs	0.042	0.261	0.726	1.174

Panel B: Standard Deviation of Absolute Forecast Errors

	Estimation method: 1 yr rolling OLS				Estimation method: 3 yr rolling OLS			
	Forecast horizon:				Forecast horizon:			
Ave	1 mo	1 yr	3 yr	5 yr	1 mo	1 yr	3 yr	5 yr
Mean	0.052	0.334	0.813	1.294	0.052	0.329	0.815	1.292
All REITs	0.050	0.31	0.754	1.19	0.050	0.304	0.756	1.199

	Estimation method: 5 yr rolling OLS				Estimation method: Full sample OLS			
	Forecast horizon:				Forecast horizon:			
Ave	1 mo	1 yr	3 yr	5 yr	1 mo	1 yr	3 yr	5yr
Mean	0.052	0.330	0.814	1.285	0.052	0.318	0.780	1.231
All REITs	0.050	0.305	0.758	1.193	0.050	0.295	0.727	1.145

	Estimation method: hybrid beta			
	Forecast horizon:			
Ave	1 mo	1 yr	3 yr	5yr
Mean	0.052	0.216	0.385	0.495
All REITs	0.050	0.255	0.591	0.857

Notes: Table 11 reports the mean and standard deviation of the absolute forecast errors by using the five-factor and the hybrid beta models as cost of equity capital models for type portfolios of REITs. The period covered is January 1997 to

December 2014. We compare the hybrid beta model to 4 five-factor model estimation methods: 1-year, 3-year, and 5-year rolling window and full sample OLS regressions. After we obtain the factor loadings for each firm with both the five-factor (rolling and full sample regressions) and the hybrid beta models, we calculate the cost of the equity capital estimates by using the long run average of market premium risk, risk-free rate, SMB, HML, RMW and CMA. The monthly forecast errors are obtained as the difference between the 1-month ahead realized return and the cost of equity capital estimates based on our five-factor model. Given the monthly time series of forecast errors, we obtain absolute forecast errors for the 1-month, 1-year, 3-year and 5-year horizons. *Ave* indicates the average of absolute forecast errors for all REITs.

The superiority of the hybrid beta approach in terms of predictive ability is evident, and all of the hybrid beta estimates are associated with errors that are far more stable over time than those produced by using the five-factor model. This is even more noticeable when we analyze the long-time horizons for both the mean (Panel A) and standard deviation (Panel B).

5. Conclusions

Reliable estimates of the cost of equity are critical so that managers can make capital budgeting decisions. To discount future cash flows, managers need statistical tools that provide them with estimates of future excess returns as accurate as possible. There are many models that have been used to estimate the cost of capital, but, in the literature, there is no consensus on which model provides a better analysis.

The goal of this study is to identify a model that can be used by REIT industry practitioners to accurately estimate the cost of equity capital. Out-of-sample forecasts have shown that the predictive ability of the "hybrid beta" approach offers statistically robust and more accurate estimates in comparison to the Carhart four-factor, REIT-factor, and Fama French five-factor models.

In our analysis, we compare the forecasting ability of all of these models by using two different approaches: running full-sample OLS regressions, and 1-year, 3-year and 5-year rolling window OLS regressions. To evaluate the predictive ability of these models, we consider both near and more distant forecast horizons and, precisely, we compare the 1-month, 1-year, 3-year and 5-year out-of-sample forecast accuracy of each estimation method applied.

We have highlighted that the hybrid beta method outperforms the four-factor, REIT-factor and five-factor models for near and distant horizons at the individual and portfolio-levels because this method combines the qualities of both the rolling and full-sample regressions by incorporating prior information based on firm fundamentals.

The reason why the hybrid beta method is more accurate might lie in the estimation method of the factor loadings: shrinkage is more powerful in this model because the prior is unique to each firm and incorporates the characteristics of multiple firms and economic conditioning variables.

The choice of the estimation method has a greater impact. In particular, the hybrid beta approach produces the lowest forecast errors and its accuracy, compared to the rolling and full-sample regressions, increases with longer horizons.

Given these findings, many researchers and practitioners should question the common use of using rolling regressions for betas in the REIT sector and consider the use of a better approach that provides more reliable and accurate estimations.

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