Time varying Integration of REITs with Stocks: A Kalman Filter Approach

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Abstract

This paper tests the level of market integration between Equity Real Estate Investment Trusts (REITs) and the stock market, using the Korajczyk (1996) market integration index and the Kalman-filter methodology. The Kalman-filter technique employed to capture the dynamic degree of integration between REITs and the stock market.

The result show that REITs were highly integrated with the stock market throughout most of the sample period from 1984:1 to 2018:12. Nonetheless, the time varying market integration index displays a number of changes, which coincide with fluctuations in the legislation governing REITs and certain market and economic events.

As a robustness check, we also compared the time varying market integration index of REITs with that displayed by Utilities. The results show that Utilities displayed a similar time varying market integration pattern to that of REITs and so indicates that the changes in market integration is not simply a REIT factor but a high yield sector phenomenon. Unlike REITs, however from April 2011 Utilities became segmented from the stock market and remained so up to the end of the sample period, even though the static integration index suggested that utility stocks were integrated with the stock market over the whole sample period.

Last, results show that the Kalman-filter approach is more useful than static models when studying the integration process and so casts strong doubt on the validity of time invariant models to measure market integration.

Keywords: *REITs; Utilities; The Stock Market; Time varying integration; Kalman-filte; Legislative changes; Market and Economic events*

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Introduction

Equity Real Estate Investment Trusts (REITs) represent a major financial asset class in many countries. Importantly, REITs have a duel personality as their performance is driven by the value of their property holdings and their stock market characteristics (Morawski et al., 2008). As a result, numerous studies suggest that REITs should provide valuable diversification benefits to stock portfolios. However, if the two asset classes are integrated they will show the same expected risk and return, which will erode any potential for diversification for investors. Consequently, the question of whether REITs are integrated with the stock market is of great concern to portfolio investors and financial institutions who invest in both asset classes.

Unfortunately, the literature on the degree of integration between US REITs and the US stock market has delivered conflicting results. On the one hand, a number of studies have found that there is a significant linear relationship between REITs and the stock market (see *inter alia*, Hartzell, et al., 1990; Liu, et al., 1990; Liu and Mei, 1992; Ambrose et al., 1992; Gyourko and Keim, 1992; Li and Wang, 1995; Ling and Naranjo, 1999; Morawski, et al., 2008; and Apergis and Lambrindis, 2011). While others have found mixed findings based on linear and non-linear tests (see *inter alia*, Okunev and Wilson, 1997; Quan and Titman, 1999; Okunev et al., 2000; Glascock et al., 2000; and Chiang, et al., 2005). Still other studies, such as those by Ibbotson and Siegel (1984), Miles et al. (1990), Geltner (1991), Ross and Zisler (1991), and Wilshire (2012), find the two asset markets are largely segmented. Alternatively, studies have found that REITs behave more like underlying property markets and less like general the stock market in the long run (see *inter alia*, Giliberto, 1990; Westerheide, 2006; Tsai, et al., 2007; and Schätz and Sebastian, 2011).

These conflicting findings result from the different observation periods and methods of analysis (correlation analysis, causality tests, co-integration tests, and GARCH models). Furthermore, the majority of the previous studies generally rely on static assumptions, which seems implausible from an economic and financial viewpoint since market integration is more of a process than an event (Bekaert and Harvey, 1995). Furthermore, Gregory and Hansen (1996) show that neglecting structural breaks in the time-series leads to the under rejection of the null hypothesis of no co-integration. That is, while the co-integration analysis can very useful in detecting the long-term equilibrium relation between the variables; it is inherently designed to capture stable linkages. Therefore, without taking into account the time variation characteristics of market integration static models do not allow the data to reveal shifts in the integration dynamics, which may result in a misleading interpretation (Adam, et al., 2010, and Adom, 2013). In other words, static models will reject integration even if integration is happening. Consequently, we need to account for the dynamics of any integration between REITs and the stock market.

A few studies that tried to account for any time variation in the integration process. For instance, Mei and Lee (1994) used latent factors to account for the variation in expected returns of REITs in a multi-factor model. Other studies meanwhile have applied the static tests to various sub-periods (Glascock et al. 2000; Morawski, et al., 2008, Simon and Ng, 2009; and Tsai, et al., 2012); or used rolling estimation (Schindler and Voronkova, 2010 and Yüksel et al., 2017). None of these approaches is particularly useful for at least two reasons. First, the use a different set of latent factors is likely to result in a different pattern of the time variation in the degree of integration. Second, splitting the data into sub-periods, or using rolling window estimation, is an *ad hoc* solution and so likely to produce conflicting results when different sub-periods or estimation windows are used. Ideally, we need a time varying methodology that does not rely on latent factors, *ad hoc* sub-periods, or estimation windows.

To overcome all these difficulties with previous approaches we use a time varying version of the Korajczyk (1996) market integration index (MII_t), estimated by the Kalman-filter (see, Kalman, 1960 and Kalman, and Bucy, 1961). We apply the Kalman-filter because of the evidence in the literature indicates that in times-series tests the Kalman-filter provides superior forecasting ability compared all other time varying models (see *inter alia*, Brooks et al. 1998; Faff, et al. 2000; Groenewold and Fraser, 2000; Lie et al., 2000; Ebner and Neumann 2005; Choudhry and Wu, 2008 and Mergner and Bulla, 2008). The Kalman-filter is also robust to non-stationarity in the data since all parts of the model are permitted to vary, as the model is re-estimated recursively (Bornhoff, 1992). The Kalman-filter has an additional advantage over latent factor models has it allows time varying parameters and latent factors to be explicitly taken into account and so is a natural way of capturing the time variation in the information set available to investors (Rockinger and Urga, 2001). Next, if GARCH models are used to estimate the conditional beta they require a knowledge of the conditional (co)variance between assets and the market portfolio first, and so only indirectly infer the integration hypothesis. In contrast, the Kalman-filter recursively estimates the time varying parameters from an initial set of priors, generating a series of conditional alphas and betas directly (Mergner and Bulla, 2008). Lastly, since the Kalman-filter estimates the market integration index (MII_t) each month we can check whether changes in REIT legislation and certain market and economic events coincide with sudden changes in the level of integration.

The closest approach to this study is that by Sing et al. (2016) where the authors examined the time varying betas of REITs for the periods from 1972 to 2013 using the single-factor and Fama-French three-factor asset pricing models. Using equity REIT (EREITs) and mortgage REIT (MREIT) returns the authors found that the betas of the two REITs declines up to 1999, but since 2000 while the MREIT betas continued to decline the EREIT betas showed a sharp increase. EREIT betas hitting a peak in 2009 and then declined due to active deleveraging, results consistent with the findings of Devaney (2012) and Devos et al. (2013). The authors however do not examine market integration.

This study makes three contributions to the literature on REIT integration with stocks. First, a major weakness of most studies is that a focus on comparative statics and do not consider the time varying nature of integration. In contrast, the Kalman-filter methodology used allows the market integration index to be time varying and so enables us to investigate the variations in the degree of integration of REITs with the stock market. Second, although some previous studies have recognised that the integration of REITs with the stock market is time varying they generally do not explain why the degree of integration changes. The current paper not only estimates the time varying integration of REITs with the stock market, but also links the fluctuations in the time varying integration to changes in the legislation governing REITs and economic and market events, and so show that the Kalman-filter is more useful than static models when studying the integration process. Lastly, to our knowledge, this is the first paper that uses the Kalman-filter to analyse the time varying integration between US REITs and the stock market.

Using monthly data for REITs and the Fama-French four-factor model over the period from 1984:1 to 2018:12, the result show that REITs were highly integrated with the stock market throughout most of the sample period. Nonetheless, the time varying market integration index displays a number of changes, which coincide with changes in REIT legislation and certain market and economic events. As a robustness check, we also compared the time varying market integration results of REITs with that displayed Utilities, as Mueller and Pauley (1995) and Ghosh, et al. (1996) argue that REITs should be compared to utility stocks, due to their high dividend yields and sensitivity to interest rate changes. The results show that Utilities display a similar time varying pattern of market integration to that of REITs, which implies that in market integration is not simply a REIT factor but a high yield sector phenomenon. Consequently, these findings cast strong doubt on the validity of the time invariant models to measure market integration.

The rest of the paper organised as follows. In Section 2, we present the market integration model followed by the data in section 3. The estimation results presented in Section 4. Section 5 compares the time varying market integration index of REITs with that displayed Utilities. The final section concludes the paper.

Methodology

Bekaert and Harvey (1995) contend that an asset will be completely integrated with the market if its returns are the same as those predicted by a model of risk-return equilibrium. An obvious way to test for integration therefore is to calculate the deviation, or pricing error, from the theoretically risk-return equilibrium (Korajczyk, 1996 and Levine and Zervos, 1998).

Traditionally, the one factor CAPM has provided the method for estimating risk-return equilibrium. The CAPM allows a linear relationship between the expected excess return and the non-diversifiable risk of a financial asset as follows:

$$R_t = \alpha + \beta(R_{mt}) + \varepsilon_t \tag{1}$$

where R_t and R_{mt} are the excess returns of REITs and on the market portfolio at time *t*, α is the unconditional measure of under or over outperformance, β is the unconditional stock market beta, and ε_t is the residual.

Numerous empirical studies have found however that the relationship between a stock's expected return and its beta is not as strong as the CAPM predicts and that some other risk factors explain returns better than beta. In particular, a number of studies have suggested that a multifactor asset pricing model should be used to assess the performance of REITs (see *inter alia*, Anderson et al., 2005; Clayton and MacKinnon, 2003; Lizieri et al., 2007; Titman and Warga, 1986, Liu and Mei, 1992, and Chiang, et al., 2005). Therefore, we use the Fama-French four-factor model to estimate the risk-return equilibrium of REITs, as in equation (2).

$$R_t = \alpha + \beta_1(R_m) + \beta_2(SMB) + \beta_3(HML) + \beta_4(MOM) + \varepsilon_t \tag{2}$$

where, SMB mimics the "small firm anomaly", HML mimics the "value stock anomaly", and MOM is the Carhart (1997) the momentum factor. We include the SMB factor as previous studies show that REIT returns are significantly related to the size factor (see *inter alia*, Peterson and Hsieh, 1997, Clayton and MacKinnon, 2003, and Anderson et al., 2005). The value factor (HML) is included as REITs generally have large current cash flows and only modest growth opportunities and so should display a significant value factor. Lastly, we include the momentum factor (MOM), as Chui, et al. (2003) reported that REIT momentum profits are stronger than momentum effects in other US industries, a finding confirmed by Ling and Ryngaert (1997), Hung and Glascock (2010), and Derwall et al. (2009). The model parameters estimated by Ordinary Least Squares (OLS).

According to Korajczyk (1996) and Levine and Zervos (1998), if an asset is perfectly integrated with the market, then the pricing error (α), from the theoretically equilibrium price, in Equation (2), should be equal to zero. Levine and Zervos (1998) proposed that the negative of the absolute value of (α) to represent market integration, as follows:

$$\text{MII} = -|\widehat{\alpha}| \tag{3}$$

Although, the OLS estimation of equation (2) is straightforward, in practice it is not reasonable to assume that the level of integration is constant. Hence, we use a time varying parameter model to test the integration of REITs with the stock market, by formulating the following state space models, estimated by the Kalman-filter:

$$R_t = \alpha + \beta_1(R_m) + \beta_2(SMB) + \beta_3(HML) + \beta_4(MOM) + \mu_t \tag{4}$$
$$\alpha_t = \alpha_{t-1} + \varphi_t \tag{5}$$
$$\beta_{1,t} = \beta_{1,t-1} + \theta_t \tag{6}$$

Equation (4) is the measurement, or observation equation, equations (5) and (6) are the state, or transition equations. The intercept (α) is now the conditional alpha and (β_1) the conditional stock market beta. The coefficients of SMB, HML and MOM assumed to be constant, as we are only interested in the time varying nature of (α) and (β_1). The μ_t, φ_t, θ_t and are error terms that are assumed to be normally distributed with zero mean and constant variance; serially uncorrelated and independent of each other. In this way, the dynamics of the integration process assessed by employing the time varying market integration index (MII_t), estimated by the Fama-French four-factor model, defined as follows:

$$\text{MII}_t = -|\widehat{\alpha}_t| \tag{7}$$

To estimate the state space model by the Kalman-filter requires some assumptions about the stochastic behaviour of the conditional (α) and (β). The most widely used characterisation being the random walk. There are three advantages to assuming that (α) and (β) follow a random walk. First, the random walk model is quite general in nature because it covers a large number of time paths, or gradual coefficient variation, reasonably well and so avoids model specification error when generating the time varying coefficients with more explicit structural models. Second, the random walk assumption removes the need to use leads and lags in asset and market indexes returns in order to correct for thin trading effects. Lastly, in contrast to GARCH models, which infer integration indirectly, the Kalman-filter generates conditional (α) and (β) directly (Mergner and Bulla, 2008).

Data

Data for this study are monthly time series. The sample period is from 1984:1 until 2018:12, 420 observations. The sample data period covering major changes in the legislation governing the management of REITs. Among these changes, Chui, et al. (2003) note, have been changes in management style, ownership structure, legal environment, and information flows.

Chan et al. (2003) provide an overview of the various tax reforms in the US REIT sector since the 1960s. In particular, The Tax Reform Act of 1986 curtailed the tax shelter aspects of real estate and liberalized the extent to which REITs could manage their property, where previously REITs had to rely on outside contractors. In other words, the 1986 Tax Reform Act transformed REITs from a tax play to an economic play.

The Tax Reform Act of 1993 dropped the rule that an institutional investor was a single investor when calculating the fraction of shares owned by the five largest shareholders, even though the institutional represented many individuals. This change permitted more institutional investors to purchase larger blocks of REIT shares. Additionally, in the early 1990s, the creation of umbrella partnership REITs (UPREITs) permitted REITs to acquire existing properties without triggering a taxable capital gain for the seller. Both of which led greater involvement by institutions in the market and the dawn of the 'New REIT Era' (see *inter alia*, Block, 2006 and Chan, et al., 2003).

The two most recent changes to affect REITs was the introduction of REITs into the S&P 500 index in 2001 and the re-classification of REITs into a new Global Industry Classification Standard (GICS) Real Estate, announced in November 2014.

The sample period also includes a number of economic and market shocks: the Dotcom Bubble and a number of periods of expansion and contraction in the US economy, as defined by the National Bureau of Economic Research (NBER).

The REIT data represented by the monthly returns of the EREIT index from the NAREIT website. The Utility index data (UTIL)[1], the equity benchmarks including a value-weighted market proxy excess return (RMF), a size mimicking factor portfolio (SMB), a value mimicking factor portfolio (HML), the momentum factor (MOM) and risk-less rate (TB), downloaded from Kenneth French's website. Because the equity factors (SMB, HML and MOM) are calculated from equity returns, they are most appropriate for explaining the riskiness of REIT and utility stock returns.

Table 1 illustrates statistical properties of REITs, UTIL, RMF, SMB and HML and MOM.

Table 1: Summary Statistics: Monthly Data 1984:1 to 2018:12

Asset Class	**REIT**	**UTIL**	**RMF**	**SMB**	**HML**	**MOM**
Mean	**0.68**	**0.64**	**0.65**	**0.03**	**0.22**	**0.55**
Standard Deviation	**4.99**	**3.86**	**4.36**	**3.05**	**2.89**	**4.46**
Correlation	**REIT**	**UTIL**	**RMF**	**SMB**	**HML**	**MOM**
REIT	**1.00**					
UTIL	**0.45**	**1.00**				
RMF	**0.56**	**0.46**	**1.00**			
SMB	**0.26**	**-0.12**	**0.21**	**1.00**		
HML	**0.20**	**0.15**	**-0.23**	**-0.27**	**1.00**	
MOM	**-0.25**	**-0.03**	**-0.18**	**0.04**	**-0.18**	**1.00**

Table 1 shows that REITs displayed the higher average excess returns than the stock market over the sample period, but at the cost of a higher risk. REITs showing a significant positive correlation with the stock market (0.56), a positive correlation with the size factor (0.26) a positive correlation with the value factor (0.20) and a negative correlation with the momentum factor (-0.25).

[1] We use the utility stock data from the 49 Industry classification in Kenneth French's website.

Table 1 also shows that Utilities displayed slightly lower average excess returns than the stock market and REITs over the sample period, but with a substantially lower risk. Utilities showing a significant positive correlation with REITs (0.45) and the stock market (0.46), a negative correlation with the size factor (-0.12), a positive correlation with the value factor (0.15) and an insignificantly negative correlation with the momentum factor (-0.03).

Results

We first estimate the constant parameter versions of equations (1) and (2) by OLS, to compare the performance of the one factor CAPM and Fama-French four-factor model, and to the estimate the lower 95% confidence interval of the time varying market integration index. For robustness, we compute Newey-West heteroskedastic robust standard errors and report adjusted R-squared values. Results reported in Table 2.

Table 2: Static REIT OLS Results: Monthly Data 1984:1 to 2018:12

REITs	CAPM	SE	FF4	SE
Constant	0.27	0.23	0.13	0.19
RMF	0.64	0.11*	0.67	0.08*
SMB			0.40	0.08*
HML			0.66	0.12*
MOM			-0.09	0.07
Adjusted R-Sq.	0.31		0.48	

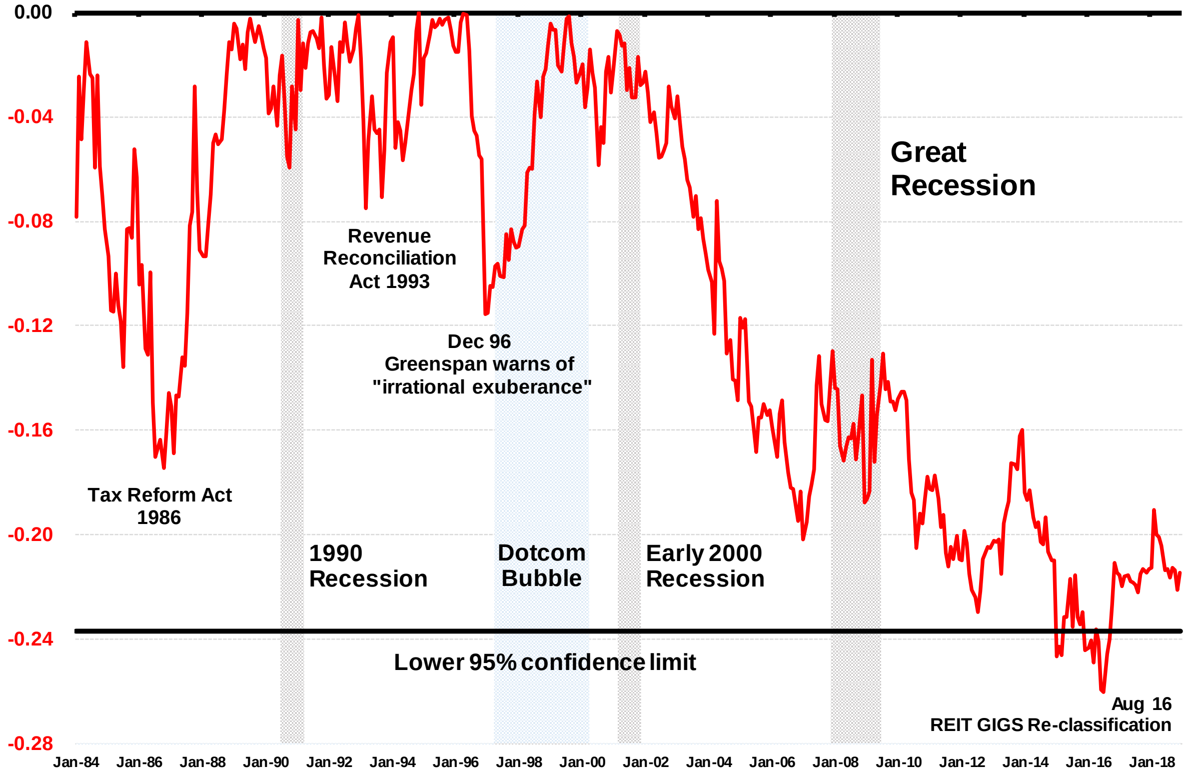
Note: * indicates significance at the 5% level

Table 2 shows that using either the one factor CAPM or the Fama-French four-factor model the intercept terms are not statistically significant different from zero, at the usual levels. The other feature of Table 2 is that the Fama-French four-factor model exhibits a higher explanatory power than the one factor CAPM and so should be used when examining the performance of REITs, confirming the results of previous studies. The SMB factor loading for REITs is both positive and statistically significant. This suggests that REITs are more mid to small cap orientated relative to the stock market. The HML factor loading for REITs is both positive and statistically significant, which implies that REITs are more value oriented than most the stock market. The momentum factor (MOM) is insignificantly negative, which suggest that momentum does not play much of a role in REIT returns. So using the intercept (α) from the Fama-French four-factor model the time invariant market integration index would be (-0.13), which suggests that REITs and the stock market were integrated throughout the whole sample period.

To calculate the time varying market integration index (MII_t) of REITs, we employ the Kalman-filter to equations 4 to 6 using data from 1980:1 to 2018:12. We then discard the first four years values of (α), due to the nature of Kalman-filter approach that generates estimates with large errors at the initial stages (see, Brooks et al., 1998 and Hearn, 2010). In other words, the exclusion of the first four years of (α) avoids any bias due to start-up problems. The results plotted in Figure 1, together with the lower 95% confidence interval obtained from the constant parameter OLS estimation of the Fama-French four-factor model.

As can be seen in Figure 1, from 1984:1 almost all estimates of the time varying market integration index are inside the lower 95% confidence interval, implying REITs were integrated with the stock market over the whole sample period. Nonetheless, it is evident from Figure 1 that the time varying market integration index displays a high degree of variation.

Figure 1: REITs Time varying Integration with the Stock Market: Monthly Data 1984:1 to 2018:12



The time varying market integration index rising sharply following the 1986 Tax Reform Act and essentially staying at zero from October 1989 until December 1992, just before the 1993 Revenue Reconciliation Act, indicating complete integration between REITs and the stock market. From January 1993, however, the time varying market integration index initially fell quite sharply only to quickly rise to zero in May 1996, indicating complete integration. After May 1996, the time varying market integration index once again fell sharply, until December 1996 when Alan Greenspan (the FED's chairman) warned of "irrational exuberance" in the stock market and the start of the Dotcom Bubble. REITs becoming completely integrated with the stock market by August 1999.

Following the end of the Dotcom Bubble, in March 2000, the time varying market integration index shows a steady decline, only rising slightly in the Great Recession. Indeed, by March 2015, when S&P Dow Jones announced the implementation date for the creation of the new GICS Real Estate sector, REITs became segmented from the stock market, for a short period, until the start of "official" trading at the end of September 2016.

Is it just a REIT Phenomenon?

In this section, we compare the integration dynamics of REITs and Utilities with the stock market. We estimate the constant parameter versions of equations (1) and (2) by OLS for Utilities, to estimate the lower 95% confidence interval and to provide a comparison with REITs. For robustness, we compute Newey-West heteroskedastic robust standard errors and report adjusted R-squared values. Results reported in Table 3.

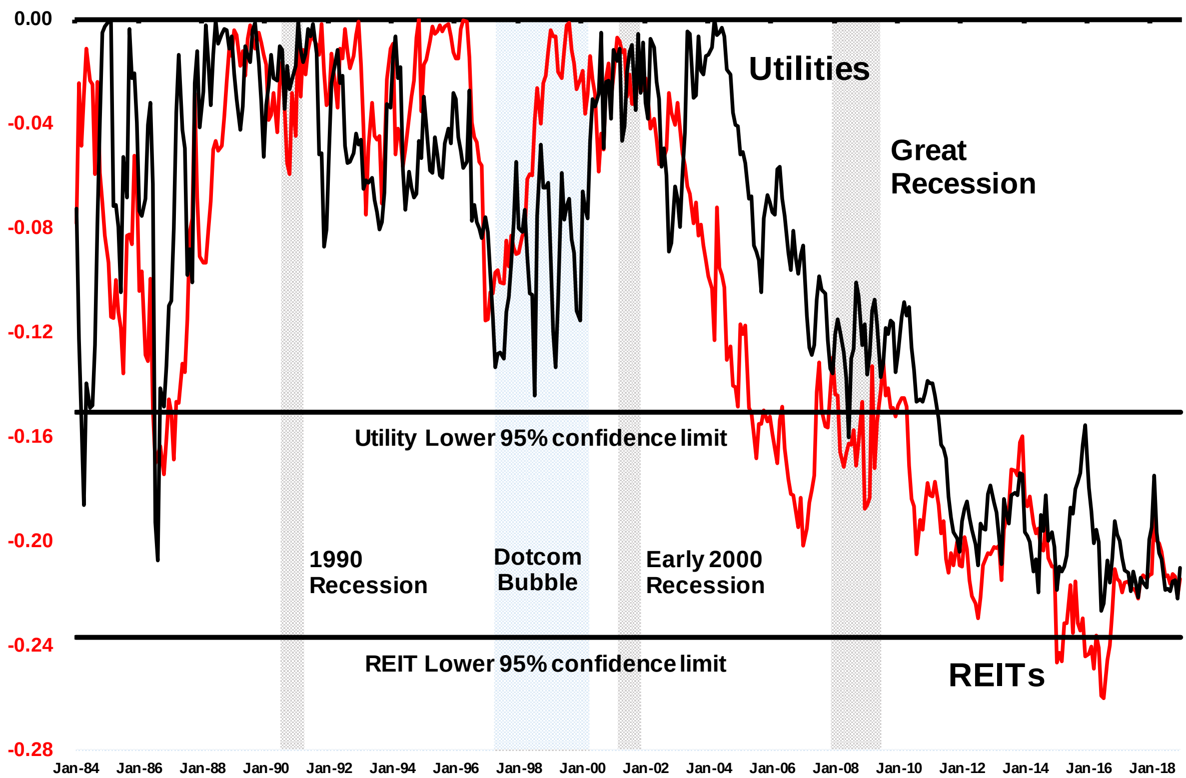
Table 3: Static Utility OLS Results: Monthly Data 1984:1 to 2018:12

Utilities	CAPM	SE	FF4	SE
Constant	0.37	0.17*	0.16	0.16
RMF	0.41	0.05*	0.52	0.04*
SMB			-0.23	0.07*
HML			0.35	0.10*
MOM			0.12	0.06*
Adjusted R-Sq.	0.21		0.31	

Note: * indicates significance at the 5% level

The results in Table 4 show that the one factor CAPM suggests that utility the stock market significantly outperformed the stock market. The Fama-French four-factor model, in contrast, displays an insignificant positive alpha. Additionally, the Fama-French four-factor model significantly increases the explanatory power of utility stocks, from 21% to 31%, suggesting that the four-factor model should be used when analysing utility stocks. Table 4 also shows that Utilities display a significantly negative size factor (SMB), as Utilities are much larger than the stock in general. Utilities also show a significant positive value factor (HML), due to their higher dividend yields and sensitivity to interest rate changes. Lastly, Utility stocks display a significantly positive momentum factor. So using the intercept (α) from the Fama-French four-factor model the time invariant market integration index for utility stocks would be (-0.16), which suggests that Utilities were integrated with stocks throughout the whole sample period.

Figure 2: Utilities and REITs Time varying Integration with the Stock Market: Monthly Data 1984:1 to 2018:12



To compare the time varying market integration index (MII_t) for Utilities with that of REITs, we employ the Kalman-filter to calculate equations 4 to 6 and plot the results in Figure 2 together with the lower 95% confidence interval from the constant parameter Fama-French four-factor model.

As can be seen in Figure 2, Utilities displayed a similar time varying market integration pattern to that of REITs. Indeed, the two market integration indexes show a significantly positive correlation (0.80) over the whole sample period. Unlike REITs, however, from April 2011 Utilities breached the lower 95% confidence interval, which suggests utility stocks became segmented from the stock market and remained so up to the end of the sample period. The results confirming the findings of Basse, et al. (2009) who find that the relationship between the Utilities and the returns of REIT has changed dramatically since the Great Recession, with REITs become more risky relative to investments in utility stocks. The results also suggest that the changes in market integration of REITs with the stock market is not simply a REIT factor but a high yield sector phenomenon.

Importantly the utility stock results show that relying on static measures of market integration can easily lead to misleading conclusions, as the static model suggested that Utilities were integrated with stocks over the whole sample period, when in fact utility stocks became segmented from 2011. Therefore, the results cast strong doubt on the validity of time invariant models to measure market integration and so show that the Kalman-filter is more useful than static models when studying the integration process.

Conclusion

This study uses monthly data and the Fama-French four-factor model to examine the degree of integration between REITs and the stock market over the period from 1984:1 to 2018:12, using the Kalman-filter. The Kalman-filter technique employed to capture the dynamic degree of integration between REITs and the stock market.

The result show that REITs were highly integrated with the stock market throughout most of the sample period. Nonetheless, the time varying market integration index displays a number of changes, which coincide with changes in REIT legislation and certain market and economic events.

As a robustness check, we also compared the time varying market integration index of REITs with that displayed by Utilities. The results show that Utilities displayed a similar time varying market integration pattern to that of REITs and so indicates that the changes in market integration is not simply a REIT factor but a high yield sector phenomenon. Unlike REITs, however from April 2011 Utilities became segmented from the stock market and remained so up to the end of the sample period, even though the static integration index suggested that utility stocks were integrated with the stock market over the whole sample period.

Lastly, results show that the Kalman-filter approach is more useful than static models when studying the integration process and so casts strong doubt on the validity of time invariant models to measure market integration.

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