Real Estate & Planning

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Working Papers in Real Estate & Planning 04/11

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Dynamic Correlations across REIT Sub-Sectors*

James Chong, California State University-Northridge
California State University-Northridge, 18111 Nordhoff Street, Northridge, CA 91330, USA. e-mail: james.chong@csun.edu

Alexandra Krystalogianni, Schroders
Schroder Property Investment Management Limited, 31 Gresham Street, London, EC2V 7QA, UK. e-mail: alex.krystalogianni@schroders.com

Simon Stevenson, Henley Business School, University of Reading
Corresponding author: Henley Business School, University of Reading, Whiteknights, Reading, RG6 6UD, UK. e-mail: s.a.stevenson@reading.ac.uk

Current Draft February 2011

* The authors would like to extend their appreciation to seminar participants at Cass Business School, City University and the University of Adelaide. An earlier version of this paper was presented at the 2007 European Real Estate Society and 2008 American Real Estate Society annual meetings. The authors would like to thank participants for comments made on the version presented.

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Abstract

The issue of whether Real Estate Investment Trusts should pursue a focused or diversified investment strategy remains an ongoing debate within both the academic and industry communities. This paper considers the relationship between REITs focused on different property sectors in a GARCH-DCC framework. The daily conditional correlations reveal that since 1990 there has been a marked upward trend in the coefficients between US REIT sub-sectors. The findings imply that REITs are behaving in a far more homogeneous manner than in the past. Furthermore, the argument that REITs should be focused in order that investors can make the diversification decision is reduced.

Dynamic Correlations across REIT Sub-Sectors

1. Introduction

The last two decades has seen a remarkable growth in the Real Estate Investment Trust market in the United States. In 1990 there were 58 listed Equity REITs with a combined market capitalization of just over $5.5bn. The early nineties saw developments such as the passing of the Omnibus Budget Reconciliation Act and the introduction of the UPREIT structure and heralded the introduction of what is often referred to as the modern REIT era[1]. Subsequent years saw an increase in the size of the sector, both in terms of market capitalization and the number of firms, with a large number of Initial Public Offerings (IPOs) in the early to mid-nineties. Indeed, the growth in the sector can be illustrated that at the end of 2010, despite the challenges of recent years, the market capitalization of the listed Equity sector in the US was US$315bn. This growth has established REITs as the primary listed vehicle for investment in the property sector[2].The primary headline advantage to obtaining REIT status is that the firm is tax transparent in that dividends are tax exempt. In order to qualify for this tax status US REITs must derive 75% of their income from real estate, have at least of 75% of their assets in real estate and are required to pay a minimum of 90% of their taxable income as dividends. Many empirical studies have shown that the characteristics of the sector changed quite substantially in during these years. A large proportion of this research has concentrated upon the nature of the relationship between REITs and the broader equity markets. For example, Glascock et al. (2000) illustrated that while REITs were segmented from the stock market prior to 1992 there was evidence of integration subsequently. Clayton and MacKinnon (2001) report that the correlation of REITs with respect to large and small cap stocks underwent a structural change in the 1990s. The authors argue that their findings can be attributed to the growing maturity of the REIT sector and the increase in institutional investment in the sector.

The increase in institutional investment from the early to mid-nineties is quite marked. Chan et al. (2003) report that average institutional ownership was only 14% in 1992. The impact of the reforms of the early nineties can be seen very quickly, with the average institutional holding rising to 19% in 1993, a trend that continued throughout the nineties, with the figure reaching 39% in 1999. For REITs listed on the New York Stock Exchange (NYSE) this figure was even higher at 45% and was in line with the average institutional ownership levels of non-REIT stocks listed on the NYSE. Lin et al. (2009) note that by 2005 this figure had exceeded 60%, with factors

such as the inclusion of REITs in the Standard & Poor's (S&P) indices in 2001 playing a role in the further increased investor acceptance of the sector. The increased level of institutional investor awareness also led to an increase in the number of analysts following the sector (Wang et al., 1995) and a reduction in the bid-ask spread of REIT shares (Below et al., 1996 and Bhasin et al., 1997). Not only has institutional investment increased generally, but the last two decades have seen a significant increase in the number of dedicated REIT mutual funds. Hartzell et al. (2010) note that the number of dedicated REIT mutual funds has increased from 16, prior to the structural changes in the market in the early eighties, to 235 in 2005, 132 of which are unique funds. Furthermore, Ling & Naranjo (2006) state that this led to an increase in the percentage of the sector's market capitalization held by REIT mutual funds rising from under 2% in 1992 to over 11% by 2003 and to over 14% by 2005 as noted by Hartzell et al. (2010).

The impact of institutional investment can be observed in other forms as well. The modern REIT era has also been characterized by an increase in the level of trading in REIT shares. SNL Financial estimate that the cross-sector aggregate average daily volume in 1993 was 3 million shares. By 2006 this figure had increased to over 50 million shares. Furthermore, Cotter & Stevenson (2008) link the heightened volume with the increase in daily REIT volatility seen during the last decade. In their analysis of REIT volatility they find evidence of a significant positive relationship between volume and volatility. A number of studies have linked flows of funds from institutions to subsequent REIT returns. Wang et al. (1995), Chan et al. (1998) and Downs (1998) all find that a positive relationship exists between increased institutional investment and REIT performance. Ling & Naranjo (2003) also find evidence that equity flows in the post 1992 period do significantly affect REIT returns. However, it should be noted that the data used in the Ling & Naranjo (2003) study consisted of total capital flows and therefore was largely comprised of capital raised during IPOs and Secondary Equity Offerings (SEOs) and thus makes it hard to isolate the impacts originating from investor behavior[3]. Ling & Naranjo (2006) specifically consider flows from dedicated REIT mutual funds. They do find evidence of REIT performance significantly impacting upon future capital flows, a finding that would also be supportive of the momentum profits observed in REIT studies such as Chui et al. (2003) and Hung & Glascock (2008, 2010). However, Ling & Naranjo (2006) do not find evidence of REIT mutual fund flows significantly impacting subsequent returns, with the exception of an observed contemporaneous relationship between unexpected flows and returns.

However, while a growing literature has examined the impact of the growth in REITs with respect to the sector's relationship with the broader equity markets, little research has been undertaken that has examined the interaction between sub-sectors. The REIT sector in the US is characterized by the predominance of focused REITs. According to the National Association of Real Estate Investment Trusts (NAREIT) less than 10% of Equity REITs are classified as diversified, the majority being specialist in a single property type. As Ro & Ziobrowski (2010) note, this is in marked contrast to direct institutional investment in the property sector, which is predominantly diversified across property types. The arguments in favor of a focused strategy are that the REIT managers should have a better understanding and knowledge of specialist markets and sectors. This is of particular relevance in the context of such a large economy as the US as it reduces the number of markets for which information and market analysis is required. As Benefield et al. (2009) note, the costs in monitoring and analyzing additional markets in order to purse a diversified strategy may well offset the performance gains that could be achieved. Hence, although the idea of focus may initially appear to go against the principles of portfolio theory and diversification, the benefits may still make economic sense. In addition, the characteristics of the US REIT market may also possibly play a role in this regard in terms of both the nature and size of the firms. As of November 2008 the average market capitalization of US Equity REITs was US$1.3bn. Even at the end of 2006, prior to the recent downturn in the market, this figure only stood at US$2.9bn. However, more importantly, in 2006 36% of Equity REITs had a market capitalization less than US$1bn, while in 2008 this figure has increased to 60%. In the context of the broader US stock market, firms with a market capitalization less than US$1bn would be classified as small cap stocks, indeed the relationship between REITs and small and mid cap firms has been well documented (e.g. Clayton & MacKinnon, 2001; Chiang & Lee, 2002 and Ziering et al., 1999). However, the size of the firm also plays a role in the ability of the firms to effectively diversify. The constraints imposed on real estate fund managers to diversify in the conventional sense of eliminating unsystematic risk have been clearly illustrated in studies such as Byrne & Lee (2000). Therefore, the combination of the small size of the average US Equity REIT, the problems inherent in diversifying a property portfolio and the size of the US real estate market could also play a role in the preference of firms to remain focused.

The second major argument in favor of focus comes from the perspective of investors. Financial theory would argue that firms should not diversify themselves but rather allow investors to make the diversification decision. While this stance normally relates to conglomerates the same argument can be advanced for firms such as REITs. However, this view is dependent on sub-

sectors behaving differently and effectively tracking their underlying markets. While earlier studies such as Mueller & Laposa (1996) and Chen & Peiser (1999) do show strong relationships between focused REITs and the underlying property markets, Young (2000) reports that the correlation between property type focused REITs increased during the nineties. It is in this context that the current study is framed. We consider the time-varying nature of the correlation between specialist REIT sectors over the period 1990 through 2008 using the Dynamic Conditional Correlation (DCC) approach of Engle (2002). We consider whether the changing dynamics within the REIT sector over the last two decades has altered the relationship between REIT sub-sectors. The results show that there has been a marked increase in the correlations between all pairings of sub-sectors since 1990. The implications for both REITs themselves and for investors are substantial. It would appear that the sector is behaving more homogeneously than previously and that differences in the performance of sub-sectors is increasingly of a relative rather than absolute nature with the movement of share prices being driven more at a sector level. This would be consistent with the increased maturity of the sector over the last decades and in particular with the growth in mainstream institutional investment in the sector.

The remainder of the paper is laid out as follows. Section 2 discusses the existing literature to have considered both the broad relationship between REITs and other assets classes and those papers to have specifically examined property type specific REITs and the issue of diversification versus focus. Section 3 presents the methodological framework adopted, presents the data analyzed and reports the summary statistics of the series'. Section 4 presents the main empirical findings, while the final section provides concluding comments.

2. Literature Review

2.1. The Changing Investment Dynamics of REITs

The examination of how investment dynamics in the REIT have altered in the modern REIT era has largely concentrated upon the interaction of the sector with mainstream stocks. As noted in the introduction, Glascock et al. (2000) found that while REITs were segmented from the broader equity market up until 1991, there was evidence of integration since 1992. The authors also found that prior to 1992 the returns for both Equity and Mortgage REITs behaved in a fashion more similar to the fixed income market while post 1992, the Equity REIT sector acted more like stocks. However, a number of studies in the late nineties and early part of the last decade, reported findings that indicated a reduced correlation between REITs and large cap stocks in the

post 1992 period. Clayton and MacKinnon (2001) report that the correlation of REIT returns with large cap stocks declined over time, with a substantially lower coefficient reported in the nineties than in the seventies and eighties. Studies such as Chandrashekaran (1999) and Conover et al. (2002) have also reported similar findings. The argument put forward by Clayton & Mackinnon (2001) is based on the premise that greater institutional investment in REITs in the nineties led to an increase in informed investors who priced REITs more in accordance with their underlying fundamentals. This, it is argued, is in contrast to individual investors, who previously dominated REIT investment, and who had largely priced REITs in an equity market context.

More recent evidence would however appear to indicate that the trend observed in the nineties has not continued and indeed the relationship between REITs and mainstream equities is more complex[4]. In particular it would appear that the relationship between the two has increased in the last decade. Cotter and Stevenson (2006) utilize a multivariate GARCH model to analyze dynamics in REIT volatility. Using a relatively short and quite distinct period of study (1999-2003), they find an increasing relationship between Equity REITs and mainstream equities in terms of both return and volatility. Chong et al. (2009) extend this analysis to consider a longer time horizon of 1990 to 2005. They provide support for both observed trends, with a downward movement in the conditional correlation in the late nineties, but an increasing relationship subsequently. This is a finding also supported by Case et al. (2010). Both Chong et al. (2009) and Case et al. (2010) use the DCC-GARCH framework that is adopted in the current study. What is of further interest in the common findings of Chong et al. (2009) and Case et al. (2010) is the difference in the data frequency used. As Case et al. (2010) notes an important issue in any analysis of the dynamics of financial time series is the data frequency adopted. The use of daily, as with Cotter & Stevenson (2006) and Chong et al. (2009), does mean that the results are more exposed to short-term volatility and market sentiment issues. As the data frequency is lowered to monthly or quarterly returns, it would be expected that more of the fundamental characteristics of the dynamics come to the fore. Therefore, while the findings of Cotter & Stevenson (2006) and Chong et al. (2009) could perhaps imply that on a daily basis Equity REITs have become more subject to the influence of market sentiment, the fact that similar results are also found using monthly returns, as in Case et al. (2010), would indicate that the shift in the relationship is more substantial than the daily results would imply when considered in isolation.

In a related stream of literature, a number of papers have considered the changing nature of the systematic risk of REITs. Crain et al. (2000) find that the unsystematic risk of REITs decreased in

the modern REIT era. In this case systematic risk was relative to the overall equity market. More recently two papers have considered the impact on REIT betas following the inclusion of REITs in the S&P indices in 2001. Feng et al. (2006) finds that the beta of Equity REITs rose by a statistically significant degree. However, the focus of this study was concerned with the inclusion and exclusion of REITs from the S&P REIT Index. Ambrose et al. (2007) specifically consider the impact of the inclusion of REITs in the S&P500 and other mainstream S&P indices. Those REITs that were incorporated into the S&P500 saw a significant increase in their beta with the S&P500 on both a weekly and daily basis. What is however of particular interest is that the beta of REITs included in the S&P500 relative to those outside the index did not significantly alter in the majority of the specifications used. Furthermore, the beta of the non-index REITs also significantly increased following 2001. The authors ran robustness tests to ensure that these findings were not due to either non-index REITs becoming more sensitive to market wide shocks or due to a general increase in market shocks. The results show that neither affect can explain the increase in the beta of the non-index REITs. These findings therefore imply that the systematic risk of the sector, and therefore the relationship with mainstream stocks, has increased. In addition, a recent paper by Chiang (2010) finds that the level of comovement within REIT sub-sectors has increased during the modern REIT period.

In contrast to the large number of empirical studies that have considered the changing nature of the relationship of REITs with stocks in general since the dawning of the modern REIT era, relatively few studies have considered the possible affect on the relationship between sub-sectors of the market. As noted in the introduction, the basis of the argument relating to REITs being focused relates to two key issues. Firstly, that by adopting a focused strategy, a REIT reduces the number of markets it has to follow, thereby creating efficiencies that would potentially offset any gains obtained from diversifying into additional sectors. Secondly, that the markets prefer REITs to be focused, as it allows investors to make the diversification decision themselves.

2.2. Corporate Diversification

In the broader finance context the issue of corporate diversification and the relative merits and problems inherent in it have been subject to a wide-ranging literature. Early studies did indeed argue in favor of corporate diversification often drawing on issues such as enhanced operating efficiency and benefits in relation to debt capacity and tax liabilities[5]. However, a large number of papers during the nineties reported the presence of a diversification discount, arguing that corporate diversification destroyed value. Lang & Stulz (1994) find that the Tobin's q of

diversified firms is not only lower than that for focused firms but it is also less than the average across all companies examined. Furthermore, these results are robust once industry effects are taken into account. Studies such as Berger & Ofek (1995), Comment & Jarrell (1995) and Denis et al. (1997, 2002) also provide evidence of a diversification discount in firm value. Comment & Jarrell (1995) argue that firms who do diversify fail to take advantage of diversification benefits, while both Berger & Ofek (1995) and Comment & Jarrell (1995) provide evidence indicating that the trend away from corporate diversification towards specialization was associated with significant increases in shareholder wealth. Non-optimal allocation of capital resources (Gertner et al., 2002, Dittmar & Shivdasani, 2003 and Ahn & Denis, 2004) and the non-optimal allocation of a diversified firms debt burden across segments (Ahn et al., 2006) have also been proposed as possible causes of the observed diversification discount.

A number of papers have also linked the diversification issue with agency costs. Denis et al. (1997) argue that agency problems are a major contributory factor behind firms maintaining a diversified strategy. This is based upon the benefits to managers that may arise from diversification, such as greater prestige due to managing a larger company, increased compensation packages and that diversification may make the management team less dispensable. The paper finds that the move during the late eighties and nineties towards corporate focus is in part attributable to market forces and increased external monitoring. Jirapon et al. (2008) report that diversified firms whose directors hold multiple board positions, thereby reducing their ability to act as effective monitors of corporate activity, observe a deeper diversification discount.

However, the evidence relating to the presence of a diversification discount is not consistent and there are also a number of papers to have provided contrasting findings, or alternatively queried the basis on which the existing empirical evidence is based. As Lang & Stulz (1994) argue, the appearance of a diversification discount may in part be due to poorly performing companies diversifying in order to seek out growth opportunities. The comparison they undertake is constrained by the fact that the only comparison possible is the Tobin's q of a diversified firm with the average Tobin's q for specialist firms in each industry. Therefore, the perceived presence of a diversification discount is based on the assumption that the Tobin's q for segments of a diversified firm is equal to the average figure for focused firms in those industries. Lang & Stulz (1994) therefore consider the performance of firms that diversify, finding that they are already poor performers, and the seeking of growth opportunities is a possible contributory factor behind the diversification discount. Hence, diversification itself is not an indicator of poor performance,

rather the poor performance may have preceded and in part contributed to the decision to diversify. Villalonga (2004a) and Hyland & Diltz (2002) provide support for this view with empirical results that illustrate that firms who subsequently diversified were already displaying signs of a discount. This is an argument that Graham et al. (2002) expand upon by considering corporate expansion and diversification through acquisitions. The authors show that firms that are incorporated into diversified firms are already, prior to the acquisition, priced at a discount. Therefore, once the firm is acquired it has a negative impact upon the value of the firm. In relation to arguments concerning the efficiency of the internal allocation of capital, Whited (2001) highlights possible measurement errors in Tobin's *q*. The subsequent analysis finds no evidence of inefficiencies in the allocation of capital across business segments in diversified firms. Villalonga (2004b) also highlights potential biases in the conventional means of defining diversification and business segments. Using this revised definition the author notes that the previously observed diversification discount is no longer present. Finally, Mansi & Reeb (2002) argue a major determinant of the discount is the level of leverage the firm has. The authors argue that corporate diversification leads to reduced risk. This reduced risk would therefore lead to an increase in bondholder value and a reduction in shareholder value with the level of leverage adopted by the firm a key element in the impact on shareholders. Their empirical results support this argument in that the diversification discount is more pronounced in those firms with higher leverage. In contrast, the results provided with an all equity firm sample reveal no evidence of a diversification discount.

2.3. REIT Diversification versus Focus

Those papers that have considered REIT sub-sectors have largely concentrated on broader performance issues, however, some papers have considered the issue of REIT diversification versus focus on a similar basis to the corporate finance literature. As mentioned in the introduction, Benefield et al. (2009) note that any benefits to a REIT diversifying may be offset by additional costs incurred in pursuing such a strategy. Capozza & Lee (1995) indeed illustrate this point by reporting that diversified REITs have higher average expense ratios, while Capozza & Seguin (1998) not only concur with this finding, but also note that the increase in expenses is only noticeable when a REIT diversifies by property type. The results with respect to geographic diversification do not concur with the sector diversification evidence. However, Capozza & Seguin (1998) also find that while expense costs do indeed increase as a result of diversification, the benefits from doing so in terms of increased revenue do provide at least a partial offset. Capozza & Seguin (1999) extend this analysis to consider why the markets appear to continue to

penalize diversified REITs if the higher cash flows and expenses are offsetting. They find that diversified REITs are penalized by both lenders and equity investors, providing evidence that the cost of debt and equity is higher. They argue that this is due to increased information asymmetries in that the individual segments of a diversified firm may be harder to value, a finding that has also been found in the broader finance literature (e.g. Nanda & Narayanan 1999). The increased difficulty in the valuation of the firm, due to reduced transparency, is captured by the liquidity of the firm, with diversified REITs having reduced liquidity. Danielsen & Harrison's (2007) study further examines this to consider the liquidity of REITs operating in different property sectors, finding that not only are spreads larger in diversified REITs but also for firms who operate in more volatile property sectors[6].

In relation to those papers that have considered the REIT diversification issue from an investment perspective two of the earliest were Gyourko & Nelling (1996) and Chen & Peiser (1999). Both papers reported results that indicate that diversification does not lead to improved REIT performance. Indeed, Chen & Peiser (1999) find that on a risk-adjusted basis diversified REITs underperform, while Gyourko & Nelling (1996) argue that the diversification undertaken by non-focused REITs does not actually result in significant benefits. Two recent papers, Benefield et al. (2009) and Ro & Ziobrowski (2010), have further examined the issue from the perspective of the firms investment performance. In contrast to earlier studies, neither find strong evidence in support of focused REITs significantly outperforming diversified firms.

Benefield et al. (2009) specifically consider the share price performance of focused REITs in comparison to those who adopt a diversified strategy. The study uses the conventional performance measures and the results do provide interesting reading. The primary empirical analysis involves testing for differences in the performance measures reported for the two samples. When using the S&P500, the CRSP value-weighted index and the CRSP small firm index, diversified REITs significantly outperform during the period 1995-2001, a period of poor sector performance, however, the difference is not statistically significant in the second period of 2002-2006. If a multi-factor market model is adopted, the results in the 1995-2001 period are not significant, although diversified REITs do outperform subsequently when the SNL Equity REIT Index is used as the benchmark. The results are of interest in that although they may not be consistent across different performance model specifications and sub-periods, where significant results are obtained it is with respect to diversified REITs outperforming, not the other way around. Throughout the analysis there is no evidence of focused REITs outperforming REITs

who pursue a diversified strategy. One note should be made however when considering the Benefield et al. (2009) findings. While the overall sample consists of 75 REITs only a small number are classified as diversified. In the first sub-period only 14 are categorized as such and in the second 17. Hence, the results are based upon a small sample and the performance of the individual firms concerned may well have unduly influenced the findings. Indeed, Ro & Ziobrowski (2010) note that Vornado comprises close to half of their diversified REIT sample on a value-weighted basis. Furthermore, Ro & Ziobrowski (2010) argue that the failure of Benefield et al. (2009) to control for differences in the portfolio composition of the two samples could also lead to biases in their findings. Ro & Ziobrowski (2010) undertake a broadly similar study to that of Benefield et al. (2009), however, they attempt to control for the potential biases in the earlier study. They undertake the empirical work on an equally-weighted basis, as well as the more conventional value-weighted, to control for the undue influence of a small number of very large REITs. Secondly, they also control for differences in the property sectors the diversified and focused REITs invest in. Finally, they control for possible differences in the capital structure of the two samples. The results however do not differ fundamentally from Benefield et al. (2009) in that while they do not find evidence of diversified REITs significantly outperforming focused firms, nor is there evidence of the reverse[7].

3. Methodological Framework

The data used in this analysis consists of daily data extending from January 1990 to December 2008. Sub-sector indices produced by SNL Financial are used in the analysis. The indices are value-weighted, while the sector into which the REIT is categorized is based on a minimum 75% holding in the sector in question. The following sectors are examined in the study; Diversified, Healthcare, Hotel/Lodging, Industrial, Office, Retail, Residential and Self-Storage[8]. The use of value-weighted index data should be noted. As papers such as Ro & Ziobrowksi (2010) argue sub-sector REIT data can be unduly influenced by the presence of a small number of large cap firms. Whilst in the context of their study this related specifically to diversified REITs, the same issue will arise in the majority of the sectors. It is therefore possible that the results noted here are at least in part driven by large cap REITs. However, it should be noted that Ambrose et al. (2007) found that the relationship between large cap REITs included in the S&P 500 from 2001 and mid and small cap REITs that were not, did not significantly alter.

Table 1 reports summary statistics on the different sectors. Substantial differences in the risk adjusted performance are noticeable across the sectors, indicating that over the entire period there was a significant level of divergence in performance between different REIT sectors. The Hotel and Office sectors in particular severely under perform on a risk-adjusted basis, with negative average daily returns during the entire sample period. In contrast, the performance of sectors such as Healthcare, Residential and Self-Storage is far stronger. The skewness and kurtosis figures do indicate non-normality in a number of cases, particularly in the case of the kurtosis figures.

{Insert Tables 1 and 2}

Table 2 reports the unconditional correlation coefficients across both the entire sample period and four different sub-periods. What is immediately noticeable is that there is a marked trend in the coefficients. During the period 1990-1994 the average pairwise correlation was 0.1355. Furthermore, the range of the coefficients was relatively large, from –0.0231 (Hotel-Residential) to 0.3347 (Retail-Residential). The low correlations indicate that REITs during this period were not a homogeneous asset class with substantial variation in performance and co-movment. These findings imply substantial diversification benefits within the REIT sector and can perhaps be attributed to the relative immaturity of the sector at the time. The results are also of interest in the context of papers such as Mueller & Laposa (1996) and Chen & Peiser (1999) who provided evidence of a strong relationship between REITs and their underlying property sector. Furthermore, the coefficients are consistent with the findings of Ooi et al. (2009) who show that in the early nineties the idiosyncratic risk of REITs was extremely high. The results for this specific sub-period also need to be considered in the context of the changes that were occurring in the sector at the time. For much of this time US REITs remained a small and thinly traded sector with a low level of institutional investment. The low level of trading is of particular importance due to the use of daily data in this paper. The unconditional coefficients therefore could merely be capturing the nature of the market during the final years of the pre-modern REIT era. Furthermore, the underlying real estate sector was undergoing a major correction during the first part of this sub-period.

However, despite the caveats that need to be clearly considered in any examination of data from the early nineties, what is evident across the four sub-periods is that there is marked increase in the correlations across the overall sample. The average unconditional coefficient increases from 0.1355 (1990-94) to 0.5384 (1995-99) to 0.7118 (2000-04) to 0.9182 (2005-08). In the 1995-99

and 2000-04 periods the range (0.35 to 0.37) and standard deviation (approximately 0.09) of the coefficients is stable in comparison with the first period. In the late nineties the increase in the correlations is particularly evident, with the lowest reported coefficient for 1995-99 (0.3987) being higher than the largest figure reported in the first half of the decade. These findings confirm the results of Young (2000) who noted an increase in the correlations during the nineties. Yet, this trend continued into the subsequent decade. Furthermore, the period of 2005-08 saw not only the average correlation reach 0.9182 but also a distinct tightening of the coefficients. The standard deviation of the correlations fell to 0.02 and the range was reduced to 0.11 with the lowest figure being 0.8601 (Industrial-Self Storage) and the highest 0.9704 (Office-Retail). However, just as the results from the early nineties need to be examined in the context of that time, so do the findings from the 2005 through 2008 period. This time period obviously captures the impact of the credit crisis and the downturn in the underlying real estate markets. Furthermore, the first part of the period saw the later stages of the sustained REIT boom that had begun in 2000.

While this analysis does provide preliminary evidence of a changing dynamic in the correlation coefficients in the sector it is limited as it purely considers the relationships across sub-periods. However, while a number of simple alternatives are available in order to more formally consider the time-varying nature of the correlations they are not without problems. Simple rolling unconditional correlations are an alternative, and were used in the Young (2000) study. However, as Case et al. (2010) note, the choice of window used in either a rolling estimation or in an exponentially weighted moving average framework is subjective, with no strong theoretical basis underpinning the choice. Furthermore, Forbes & Rigobon (2002) note that unconditional correlations can exhibit bias. This can be particularly noted during periods of increased volatility, when an upward bias can be introduced into the correlation coefficients. Therefore, the empirical analysis is undertaken using a multivariate GARCH (Generalized Autoregressive Conditional Heteroscedasticity) framework. GARCH models have the broad advantage in that they avoid the need of having to assume a homoscedastic error term, which is often problematic in the context of financial time series due to factors such as volatility clustering, particularly when daily data is examined. However, the advantages of using a GARCH framework in terms of heteroscedasticity also extend to the modeling of correlations. In particular, the potential bias noted by Forbes & Rigobon (2002) in the case of unconditional correlations is eliminated. Given the increase in volatility in REITs over the period under examination, as highlighted in papers such as Cotter & Stevenson (2008) and Jirasakuldech et al. (2009), this provides further rationale behind the use of GARCH based conditional correlations that are not subject to the same upward bias.

ARCH models assume that the volatility of the series in question is a deterministic function of past returns and is thus conditional on previous squared error terms. The GARCH (1,1) specification, as proposed by Bollerslev (1986), further allows the conditional variance of the series to be dependent on it's own lags and is felt to capture the volatility dynamics of the vast majority of financial time series (Engle, 2004). A standard univariate GARCH (1,1) specification can be displayed as follows:

$$x_{i,t} = \mu + \varepsilon_{i,t} \tag{1}$$

$$\varepsilon_{i,t} \sim N(0, h_{ii,t}) \tag{2}$$

$$h_{ii,t} = \gamma_i + \alpha_i \varepsilon_{i,t-1}^2 + \beta_i h_{ii,t-1} \tag{3}$$

where the mean is described by a first order VAR, and univariate volatility follows a GARCH process. The specification is subject to $\gamma_i > 0, \alpha_i, \beta_i \geq 0, \alpha_i + \beta_i < 1$. The α and β coefficients determine the short run dynamics of the resulting volatility time series. A large β indicates that shocks to conditional variance take a long time to dissipate; that is, volatility is said to be "persistent". A large α indicates that volatility reacts intensely to recent market movements.

The use of GARCH based models in a REIT context has increased in recent years. The papers that are closest in spirit to the current study are Case et al. (2010), Chong et al. (2009) and Cotter & Stevenson (2006). As noted in Section 2, all of these papers estimate time-varying conditional correlations, although in each case their focus is concerned with the relationship between REITs and other asset classes. In relation to other REIT papers to have used GARCH models, Stevenson (2002) examined volatility spillovers using monthly data within both different REIT sectors and between REITs and the equity and fixed-income market. Papers such as Liow et al. (2009), Liow & Ibrahim (2010) and Michayluk et al. (2006) have extended the analysis of volatility spillovers and dynamics into an international context. Jirasakuldech et al. (2009) confirm that REIT volatility is time-varying and that volatility has increased in the modern REIT era. Cotter & Stevenson (2008) consider the use of a Fractionally Integrated GARCH (FIGARCH) specification to examine the long memory properties of REIT volatility, finding that it does display persistence. Furthermore, they find that increased trading volume is an important determinant in REIT

volatility. Zhou & Kang (2010) also adopt a FIGARCH model, finding that it outperforms other GARCH specifications when forecasting volatility. In a different context Hung & Glascock (2010) utilize a GARCH framework to examine momentum returns, reporting that REITs display asymmetric volatility. In addition, a number of pieces of research have also utilized GARCH frameworks in the examination of the interest rate sensitivity of REITs. Devaney (2001) and Stevenson et al. (2007) use GARCH-M specifications to consider the time-varying interest rate sensitivity of US REITs and UK property companies respectively, while Bredin et al. (2007) model the response of REITs to unanticipated changes in the Fed Funds Rate in a GARCH framework.

A number of alternative multivariate GARCH specifications are available that can be used to estimate the conditional correlations. Cotter & Stevenson (2006) in their analysis of REITs and other asset classes used the BEKK specification (Engle & Kroner, 1995). This model can be displayed as follows:

$$H_{i,t} = C_0^{*'}C_0^{*} + A_{11}^{*'}H_{i,t-1}A_{11}^{*} + B_{11}^{*'}\varepsilon_{i,t-1}\varepsilon_{i,t-1}^{'}B_{11}^{*} \tag{4}$$

where $H_{i,t}$ is the conditional variance covariance matrix at t. The BEKK does have advantages in comparison to other multivariate GARCH models such as VECH specification. In particular, the model ensures a positive definite variance covariance matrix as each matrix, C, A and B is 2 x 2 and C is restricted to be upper triangular. However, a problem with the BEKK model is that as the parameters are in quadratic form it can be difficult to interpret the coefficients. For this reason we follow Chong et al. (2009) and Case et al. (2010) and estimate the conditional correlation coefficients using the Dynamic Conditional Correlation (DCC) model of Engle (2002)[9]. The DCC model initially estimates GARCH (1,1) specifications, employing the resulting standardized residuals to estimate the time varying correlation matrix. To do this, the residuals are transformed by their estimated standard deviations $\Xi_t = \varepsilon_t \big/ \sqrt{h_t}$. The covariance matrix can be expressed as $H_t \equiv D_t R_t D_t$, where D_t is a diagonal matrix of univariate GARCH volatilities. $R_t = Q_t^{*-1} Q_t Q_t^{*-1}$ is the time varying correlation matrix, with Q_t as described by

$$Q_t = (1 - a - b)\overline{Q} + a(\Xi_{t-1}\Xi_{t-1}') + bQ_{t-1} \tag{5}$$

$\overline{Q}$ is the unconditional covariance of standardized residuals resulting from the first stage estimation, and Q_t^* is a diagonal matrix composed of the square root of the diagonal elements of Q_t. As with the standard GARCH(1,1) model the coefficients of the DCC(1,1) model are estimated by the maximum likelihood procedure using the algorithm of BFGS. The log likelihood function, under the assumption of conditional multivariate normality can be displayed as follows:

$$L(\vartheta) = -\frac{1}{2}\left[TN\ln(2\pi) + \sum_{t=1}^{T}\left(\ln|H_t| + \Xi_t' H_t^{-1}\Xi_t\right)\right] \tag{6}$$

where Ξ_t is an N x 1 vector stochastic process, with $H_t = E_{t-1}(\Xi_t \Xi_t')$, being the N x N conditional variance covariance matrix.

4. GARCH Empirical Analysis

The estimated time varying conditional coefficients for each pairing of sectors for the GARCH-DCC model are presented in Table 3. The figures reported include the coefficients for each GARCH (1,1) estimation and the DCC (1,1,) estimation. For example, for the Healthcare-Hotel/Lodging pairing, γ_1, α_1 and β_1 represent the GARCH (1,1) coefficients for the Healthcare sector, while the corresponding figures, subscripted 2, are with respect to the Hotel/Lodging sector. The coefficients *a* and *b* refer to the DCC (1,1) estimates. The estimated GARCH-DCC model appears to provide a good representation of the conditional variance of the data. The sum of the parameter $\alpha_i + \beta_i$ estimates is close to unity, suggesting strong persistence in volatility. The DCC parameters, $a + b$, which account for the conditional covariance between the sector pair, are positive and significant. This is suggestive of a strong interaction between the returns of the sectors. Again, their sum is close to one. It is worth noting that all coefficients are significant, highlighting the time varying nature of conditional variances and covariances.

{Insert Table 3}

Figure 1 presents the time varying conditional coefficients for each pairing of sectors, while Table 4 presents summary statistics on the results. Initially it is worth noting that in most cases the average conditional correlation is similar to the unconditional coefficient estimated across the

entire sample period, as reported in Table 2. In cases where this is not the case the average conditional correlation is lower. This is consistent with the problems in using the unconditional correlation as previously noted, in that during periods of increased volatility an upward bias can be introduced into the coefficients. The overall result is that the mean figure across the different pairings is reduced from 0.6891 with the unconditional figures to 0.5480 in the conditional case. In addition, the upward bias is clearly illustrated in that while the lower coefficients are not that different, it is in the higher reported correlations that the largest change generally occurs. For example, while the highest reported figure in both cases is with respect to the Retail-Residential pairing, the average conditional correlation is 0.7153 in comparison to the 0.8866 reported in Table 2.

Figure 1 graphically displays the conditional correlations over time. A number of issues are of interest, however, the consistency across the different sectors is evident. In each case the conditional correlations follow a strong upwards trend during the sample period. In the first part of the sample, not only are the majority of the correlations relatively low, implying diversification potential across REIT sectors, but they also display a relatively high level of spread across the correlations, confirming the findings for the unconditional coefficients for the period 1990-1994. Indeed, in each case there are periods of time when negative conditional correlations are reported. However, from the mid-nineties onwards there is a distinct upward trend in the conditional correlations, to the extent that by the end of the sample there are few conditional correlations reported below 0.8, and in addition, the correlations tend to be far more tightly banded than in the past. While this upward movement was in part illustrated by the figures in Table 2, these results, free of an upward bias, clearly indicate that the sector has undergone a distinct shift over the last two decades. To further illustrate the upward movement in the correlations we regress the conditional correlations on a time trend, with the coefficients reported in Table 4. In each case the regression coefficient is positive and at high levels of statistical significance. These findings imply that the sector has over time become more integrated[10].

{Insert Figure 1 and Table 4}

The implications of these findings for the REIT sector are apparent in a number of respects. The most immediate implication is that diversification potential within the REIT sector has reduced in the last two decades with the sub-sectors behaving in a more homogeneous manner than in the past. This has a number of consequences. If REITs are behaving in a more homogenous manner,

then this calls into question the investment based argument for REITs to be focused. As noted in the introduction, it is commonly argued that REITs should adopt a focused investment strategy in order that investors can make their own diversification decisions. However, this is based on an underlying assumption that performance does differ and that the share prices of REITs reflect the fundamentals of the underlying property sectors. This paper hasn't considered the comparative performance of the underlying real estate sectors therefore an explicit comparison in this regard cannot be made. However, while it cannot be definitively stated that the linkages between REITs and their respective underlying sectors has weakened during this period, it is clear that the capital markets are not differentiating between sub-sectors as clearly as in the past.

As highlighted in the introduction, a key element in any analysis of REITs over the last two decades is the growing maturity of the sector as observed by an increase in the number of listed REITs during the nineties, institutional investment and trading volume. The impact of this has been considered with respect to specific issues such as the relationship of REITs and the overall stock market (e.g. Glascock et al., 2000 and Case et al., 2010), the number of REIT analysts (e.g. Wang et al., 1995), bid-ask spreads (e.g. Below et al., 1996 and Bhasin et al., 1997), the behavior of REIT mutual funds (e.g. Ling & Naranjo, 2006 and Hartzell et al., 2010), flow of funds effects (e.g. Chan et al., 1998 and Ling & Naranjo, 2003) and volatility in REIT share prices (e.g. Cotter & Stevenson, 2008 and Jirasakuldech et al., 2009). However, few pieces of work have attempted to tie these impacts together. The growth and increased maturity of the sector may have had a number of interlinked consequences on the dynamics of REITs. In particular, while the increase in institutional investment has been directly linked to issues such as spreads and flow of funds, an element that has often been ignored is the actual nature of the investors. If the increase in institutional investment has been concentrated in mainstream equity investors then it is probable that the nature of the comparison investors make has shifted away from the private real estate market towards the broader stock market[11]. The key question is whether REITs have been increasingly analyzed on the basis of their relative attractiveness compared to other equity sectors. If this is the case, which would be consistent with an increase in equity based institutional investment, then it could be an important factor in the more homogeneous behavior of the sector. This view would also be consistent with those findings that considered the impact of noise traders. Lin et al. (2009) highlight the importance of investor sentiment in the context of REIT performance, while Barkham & Ward (1999) in their analysis of UK property companies find that only 15% of the variation in the discount to Net Asset Value (NAV) is firm specific, with the majority of the movement being driven at a sector level. Such effects could possibly explain the

findings we report in this paper and the movement away from absolute differences in the performance of REIT sectors, as observed through the low correlations in the early part of the sample, towards relative differences in the performance. The fact that our findings reveal a steady upward movement in the conditional correlations would also imply such a shift in pricing.

It is of interest that there are no discernable common patterns in the results reported here and those in Chong et al. (2009) and Case et al. (2010). Whereas both of these papers noted an upward trend in the conditional correlation of REITs and the broader equity market there were also noticeable trends in that the correlation fell in the late nineties but rose subsequently. The fact that our findings reveal no such pattern is of importance as it implies that the upward trend is not connected with the general relationship between REITs and the broader equity markets. Furthermore, this also aids in the reconciliation of results reported in papers that have considered the relationship between REITs and the general stock market and that while during the mid to late nineties there was a downward shift in the correlation, this altered during the last decade. This may be indicative of a period of time in the late nineties when REITs were providing less attractive investment opportunities than other equity sectors, and in particular technology stocks. It is therefore of interest to note that during the 1998-2000 phase, when the REIT sector underperformed the overall equity market, REIT mutual fund flows of funds were negative (Ling & Naranjo, 2006). In contrast, during the subsequent period, and particularly from 2001 to 2003, fund flows were positive at a time when the REIT sector outperformed the market. Therefore, the relative performance of REITs with respect to the overall market can be possibly seen to account for the reduced correlation. Effectively, while the headline relationship between REITs and stocks became weaker, the sector was potentially being influenced by the general market more than ever. Furthermore, during that 1998 to 2003 period it can be argued that REITs were effectively acting as a counter cyclical defensive equity sector.

The findings can also be linked to those of Benefield et al. (2009) and Ro & Ziobrowski (2010) with respect to the fact that diversified REITs did not significantly underperform their focused counterparts. The noted increased homogeneity of the sector as found with our results, perhaps helps to explain the insignificant findings reported particularly by Ro & Ziobrowski (2010). Not withstanding other issues, the fact that the sub-sectors are behaving in such a similar manner would make the identification of significant differences in the results difficult.

In addition to the broad findings and the implications contained therein, there are other points of interest in the results. In particular, while the results do clearly illustrate a strong upward trend in the correlations, there are also patterns in the time varying nature of the coefficients. In particular, it is noticeable that in the early part of the sample the correlations were actually quite high and then dropped considerably in 1990-1992. As with the overall finding this result is consistent across all sub-sector pairings. This raises a number of issues. Firstly, that the extremely low coefficients reported in the early nineties may just be a feature of that time. The lack of quality sub-sector data extending back beyond 1990 does limit our ability to analyze this fully: however it is an issue that needs to be considered. Furthermore, the results are consistent with those of Ooi et al. (2009) with respect to the levels of idiosyncratic risk present in REITs. Ooi et al. (2009) found that idiosyncratic risk was relatively high in the early nineties before reducing during the decade. However, even if one takes into account the behavior of the sector in the early part of the nineties, the upward movement in the coefficients continued to occur throughout the nineties and into the past decade.

To further consider the issues we study the relation between conditional correlations and conditional volatilities by regressing the former on the latter as follows:

$$\rho_t = \alpha + \beta_{reits}\sqrt{h_{reits,t}} + \varepsilon_t \tag{7}$$

The conditional volatility figure used is based on that for the overall Equity REIT sector and is obtained through the estimation of a standard GARCH (1,1) model. A positive beta coefficient would suggest that the conditional correlations rise with the overall volatility of the REIT sector. The results are contained in Table 5 and are in each case positive and significant. This implies that the conditional correlations rise during periods of increased volatility. This point does however need to be carefully considered. An initial reading of the results would imply that the sector behaves more homogeneously during periods of increased volatility or high market stress. Whilst this would be consistent with the broader volatility literature with respect to equity markets, the results do have to be viewed in the context that not only have the conditional correlations increased over the sample period, but as illustrated in papers such as Cotter & Stevenson (2008) and Jirasakuldech et al. (2009), so has the volatility of the REIT sector.

{Insert Table 5}

5. Conclusion

This paper has considered whether, in line with other aspects of the dynamics of the sector, the modern REIT era has altered the relationship between REIT sub-sectors in terms of their relative investment performance. The results highlight that there has been a distinct and continued upward trend in the conditional correlations between the sub-sectors since the early nineties. The findings do imply that that the sector has become more homogeneous over the last two decades. The results also reduce the strength of the investment based argument to support the view that REITs should be focused in terms of their investment strategy. If, as found here, the markets are not differentiating between different REIT sectors to the extent that they did in the past, then the argument that REITs should remain focused in order that investors can make their own real estate diversification decision is reduced. It is important to note that real estate specific issues can still arise. However, given the high level of the correlations reported, this is likely to be in relative not absolute terms, with the majority of the movement of REIT share prices being driven increasingly at a sector level. Furthermore, it needs to be emphasized that the argument in favor of focus based on the view that the monetary gains from diversification are largely offset by increased expenses remains. Furthermore, the liquidity issues with regard to diversified REITs as noted by Capozza & Seguin (1999) and Danielsen & Harrison's (2007) also do remain a justifiable issue in a REITs decision to diversify or to focus. The results should therefore be purely viewed from the perspective of the share price performance of the different sectors.

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Table 1: Descriptive Statistics of Daily Returns Series

	Average Daily Return	Standard Deviation	Skewness	Kurtosis	Minimum	Maximum
Healthcare REITs	0.0265%	1.2703%	0.3132	34.0581	-16.64%	15.22%
Hotel/Lodging REITs	-0.0019%	2.6439%	0.2126	22.7716	-33.94%	24.69%
Industrial REITs	0.0040%	1.7248%	-0.4108	48.1598	-26.27%	24.55%
Diversified REITs	0.0052%	1.3258%	0.5710	36.8222	-17.13%	18.14%
Office REITs	-0.0034%	1.5262%	-0.0764	40.7282	-22.02%	20.70%
Retail REITs	0.0164%	1.3474%	0.7141	58.4468	-19.56%	21.62%
Residential REITs	0.0214%	1.2992%	0.4365	49.8272	-19.46%	18.34%
Self Storage REITs	0.0428%	1.4995%	0.4362	33.9548	-18.37%	19.18%

Note: Table 1 presents descriptive statistics for each of the sub-sectors of the REIT market for the entire sample period, 1990-2008 The first two moments are expressed in percentage form. The skewness and kurtosis statistics have a value of 0 for a normal distribution.

Table 2: Unconditional Correlations by Sub-Period

	1990-2008	1990-1994	1995-1999	2000-2004	2005-2008
Healthcare-Hotel/Lodging	0.4777	0.0721	0.4088	0.5423	0.8998
Healthcare-Industrial	0.7143	0.1359	0.4566	0.6954	0.8801
Healthcare-Diversified	0.7841	0.2508	0.4691	0.6522	0.9379
Healthcare-Office	0.7155	0.1366	0.4363	0.7037	0.9298
Healthcare-Retail	0.8360	0.3064	0.5690	0.7592	0.9293
Healthcare-Residential	0.8109	0.1740	0.5428	0.6904	0.9284
Healthcare-Self Storage	0.7117	0.0829	0.4039	0.6343	0.9053
Hotel/Lodging-Industrial	0.4643	0.0833	0.4308	0.6266	0.8825
Hotel/Lodging-Diversified	0.5125	0.1597	0.4792	0.5811	0.9226
Hotel/Lodging-Office	0.4863	0.1143	0.4900	0.6593	0.9286
Hotel/Lodging-Retail	0.5213	0.1035	0.5325	0.6850	0.9189
Hotel/Lodging-Residential	0.4845	-0.0231	0.4965	0.6417	0.9110
Hotel/Lodging-Self Storage	0.4193	-0.0086	0.3987	0.5039	0.8827
Industrial-Diversified	0.7265	0.1972	0.5205	0.7118	0.8945
Industrial-Office	0.6956	0.1259	0.5714	0.8542	0.9108
Industrial-Retail	0.7881	0.1963	0.6486	0.8528	0.9087
Industrial-Residential	0.7576	0.1052	0.6696	0.8505	0.8854
Industrial-Self Storage	0.6561	0.0508	0.5270	0.7070	0.8601
Diversified-Office	0.7615	0.2704	0.5905	0.7336	0.9584
Diversified-Retail	0.8406	0.2907	0.6074	0.7606	0.9566
Diversified-Residential	0.8122	0.1068	0.6068	0.7285	0.9498
Diversified-Self Storage	0.7097	0.0520	0.4763	0.6192	0.9265
Office-Retail	0.7942	0.1541	0.6709	0.8697	0.9704
Office-Residential	0.7579	0.0249	0.6927	0.8783	0.9439
Office-Self Storage	0.6461	-0.0076	0.5014	0.6991	0.9135
Retail-Residential	0.8866	0.3347	0.7631	0.8478	0.9449
Retail-Self Storage	0.7663	0.1566	0.5580	0.7289	0.9168
Residential-Self Storage	0.7579	0.1496	0.5578	0.7124	0.9137
Average	**0.6891**	**0.1355**	**0.5384**	**0.7118**	**0.9182**
Standard Deviation	**0.1341**	**0.0944**	**0.0938**	**0.0981**	**0.0265**
Range	**0.4674**	**0.3578**	**0.3644**	**0.3744**	**0.1103**

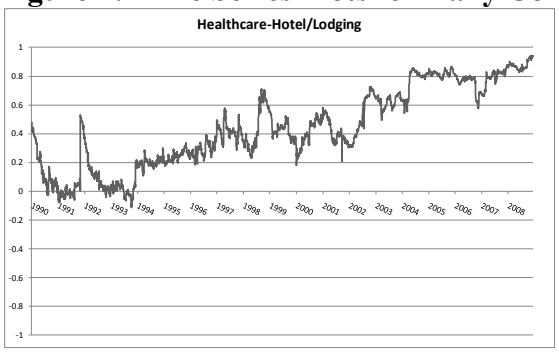
Note: Table 2 reports the unconditional correlation coefficients reported across the entire sample period, 1990-2008 and three sub-periods. The final row in the table reports the average correlation coefficient reported across each pairing for each period.

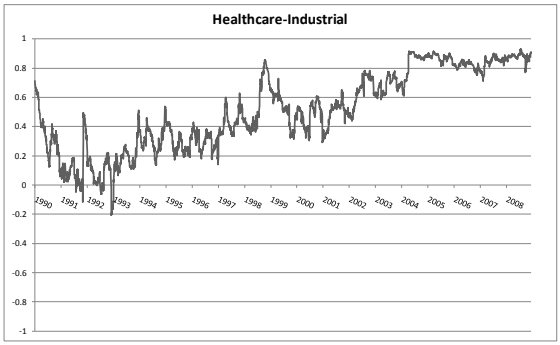
Table 3: DCC GARCH Estimates

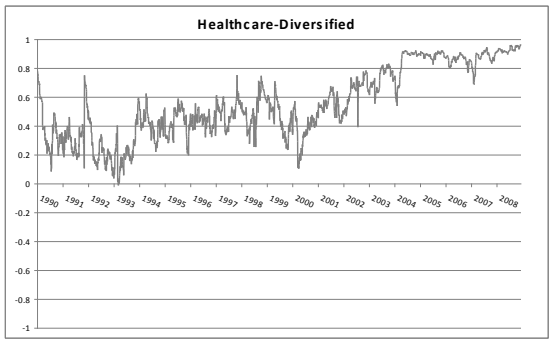
	γ_1 (*1,000)	γ_2 (*1,000)	α_1	α_2	β_1	β_2	a	b
Healthcare-Hotel/Lodging	0.0005**	0.0017**	0.0904***	0.1314***	0.9128***	0.8792***	0.0165***	0.9833***
Healthcare-Industrial	0.0004***	0.0006***	0.0690***	0.0681***	0.9322***	0.9325***	0.0215***	0.9779***
Healthcare-Diversified	0.0007***	0.0007***	0.0854***	0.0779***	0.9144***	0.9210***	0.0283***	0.9708***
Healthcare-Office	0.0005***	0.0008***	0.0776***	0.0760***	0.9242***	0.9251***	0.0217***	0.9776***
Healthcare-Retail	0.0007***	0.0008***	0.0836***	0.0938***	0.9161***	0.9029***	0.0289***	0.9705***
Healthcare-Residential	0.0007***	0.0007***	0.0921***	0.0941***	0.9083***	0.9059***	0.0379***	0.9611***
Healthcare-Self Storage	0.0005***	0.0006***	0.0772***	0.0676***	0.9243***	0.9341***	0.0260***	0.9739***
Hotel/Lodging-Industrial	0.0019***	0.0007***	0.1310***	0.0800***	0.8800***	0.9226***	0.0167***	0.9832***
Hotel/Lodging-Diversified	0.0018***	0.0006***	0.1299***	0.0856***	0.8816***	0.9178***	0.0312***	0.9684***
Hotel/Lodging-Office	0.0020***	0.0009***	0.1376***	0.0886***	0.8755***	0.9153***	0.0158***	0.9841***
Hotel/Lodging-Retail	0.0016***	0.0009***	0.1286***	0.1106***	0.8810***	0.8880***	0.0267***	0.9729***
Hotel/Lodging-Residential	0.0019***	0.0007***	0.1416***	0.1162***	0.8706***	0.8866***	0.0302***	0.9692***
Hotel/Lodging-Self Storage	0.0017***	0.0006***	0.1237***	0.0740***	0.8862***	0.9295***	0.0247***	0.9748***
Industrial-Diversified	0.0009***	0.0007***	0.0763***	0.0776***	0.9226***	0.9213***	0.0358***	0.9628***
Industrial-Office	0.0006***	0.0008***	0.0699***	0.0684***	0.9312***	0.9309***	0.0291***	0.9702***
Industrial-Retail	0.0007**	0.0008**	0.0666***	0.0795***	0.9325***	0.9161***	0.0272***	0.9719***
Industrial-Residential	0.0007***	0.0005***	0.0707***	0.0780***	0.9293***	0.9217***	0.0396***	0.9588***
Industrial-Self Storage	0.0007***	0.0007***	0.0660***	0.0691***	0.9332***	0.9332***	0.0235***	0.9752***
Diversified-Office	0.0008***	0.0012***	0.0800***	0.0832***	0.9187***	0.9155***	0.0430***	0.9547***
Diversified-Retail	0.0010***	0.0013***	0.0886***	0.1145***	0.9076***	0.8797***	0.0400***	0.9587***
Diversified-Residential	0.0008***	0.0009***	0.0864***	0.1057***	0.9130***	0.8926***	0.0529***	0.9458***
Diversified-Self Storage	0.0006***	0.0007***	0.0785***	0.0706***	0.9216***	0.9313***	0.0386***	0.9599***
Office-Retail	0.0008***	0.0008***	0.0731***	0.0828***	0.9265***	0.9137***	0.0325***	0.9661***
Office-Residential	0.0008***	0.0006***	0.0812***	0.0912***	0.9206***	0.9111***	0.0505***	0.9475***
Office-Self Storage	0.0011***	0.0008***	0.0815***	0.0739***	0.9176***	0.9272***	0.0267***	0.9718***
Retail-Residential	0.0014*	0.0011***	0.1264***	0.1183***	0.8700***	0.8799***	0.0607***	0.9373***
Retail-Self Storage	0.0012***	0.0011***	0.1206***	0.0906***	0.8759***	0.9116***	0.0443***	0.9542***
Residential-Self Storage	0.0007***	0.0009***	0.0909***	0.0749***	0.9090***	0.9270***	0.0478***	0.9502***

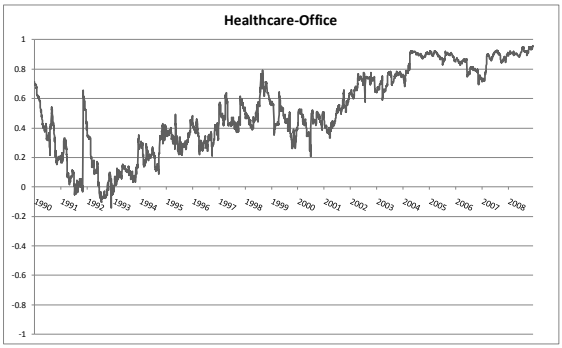
Note: Table 3 reports the coefficients from the GARCH-DCC estimations. The γ, α and β coefficients refer to the respective GARCH (1,1) model, with a subscript of 1 refer to the first sector and a subscript of 2 referring to the second sector noted in the first column of the table. The a and b coefficients refer to the DCC (1,1) estimates. * indicates significance at the 10% level, ** at the 5% level and *** at the 1% level.

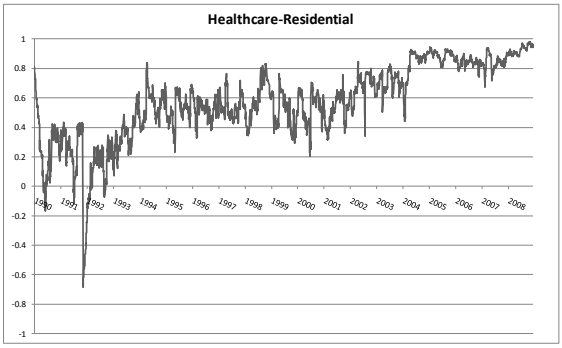
Figure 1: Time Series Plots for Daily Conditional Correlations

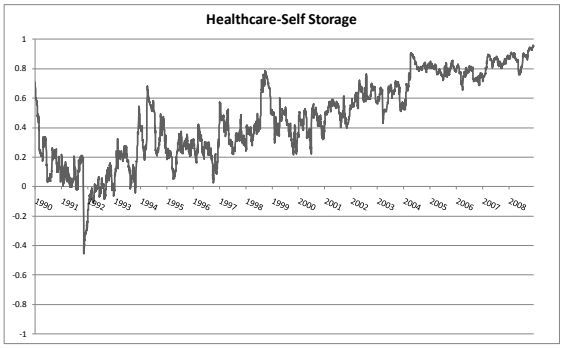


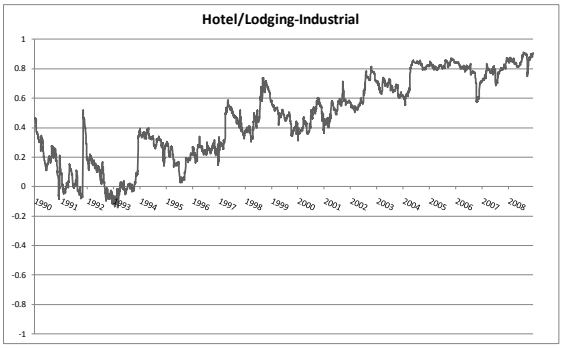


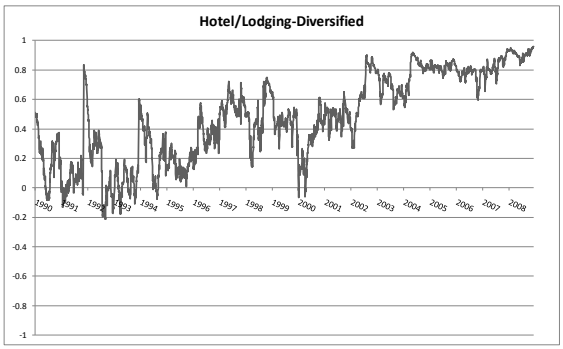


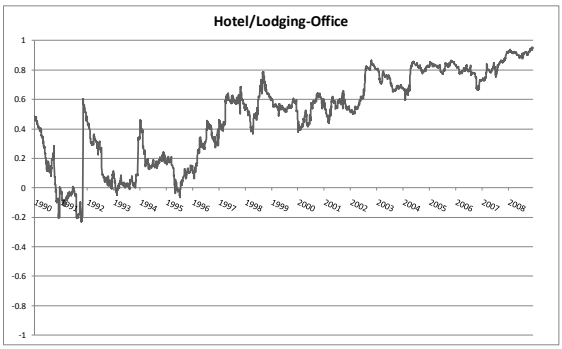




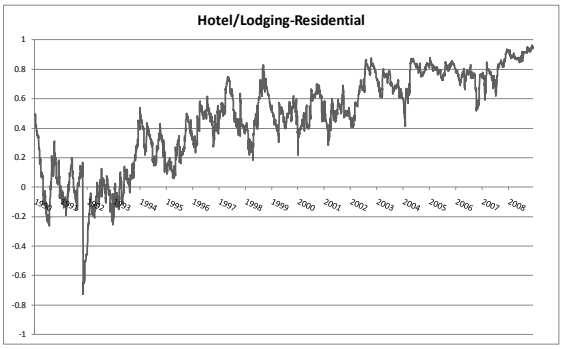


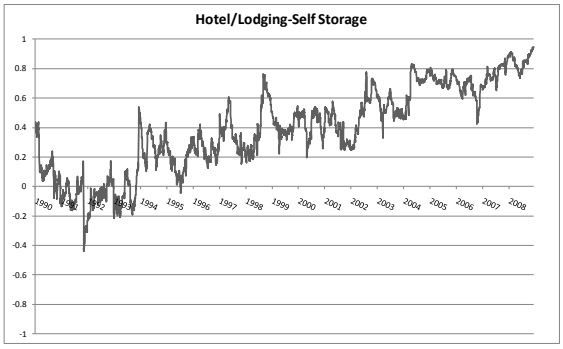


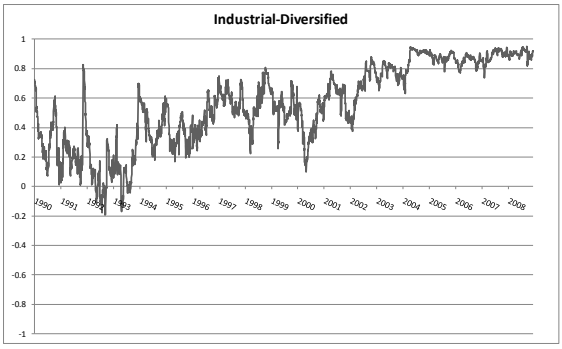

Hotel/Lodging-Diversified

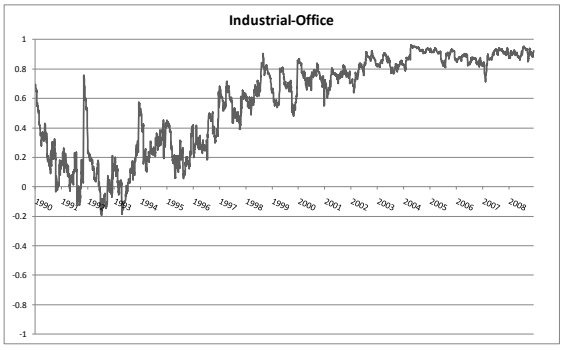

Hotel/Lodging-Office


Hotel/Lodging-Retail

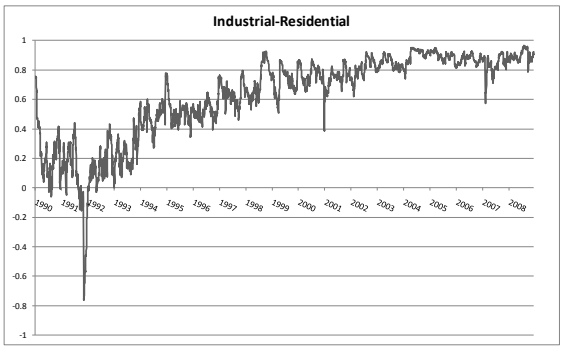

Hotel/Lodging-Residential

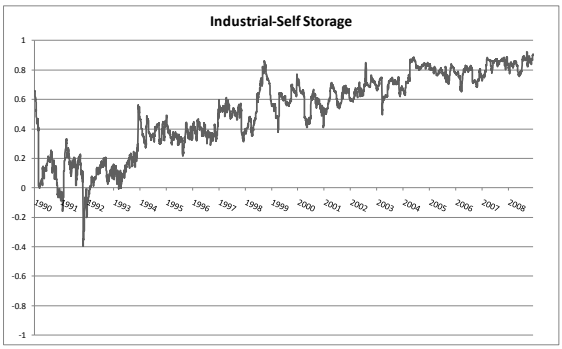

Hotel/Lodging-Self Storage

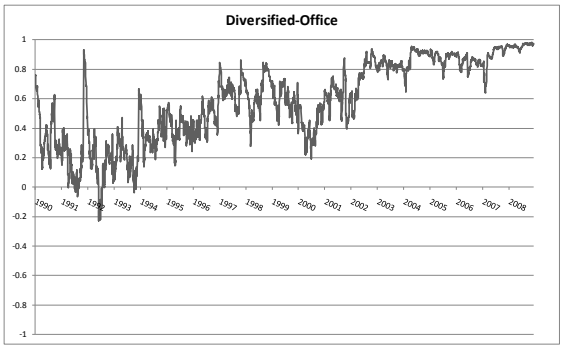

Industrial-Diversified

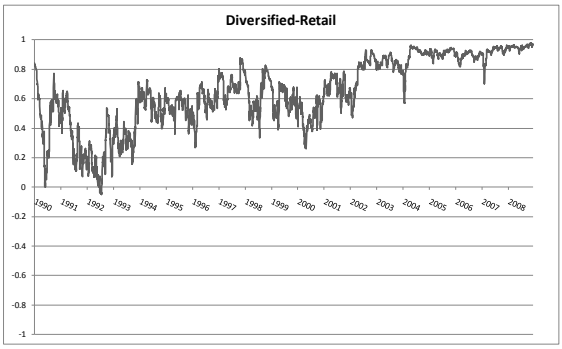

Industrial-Office

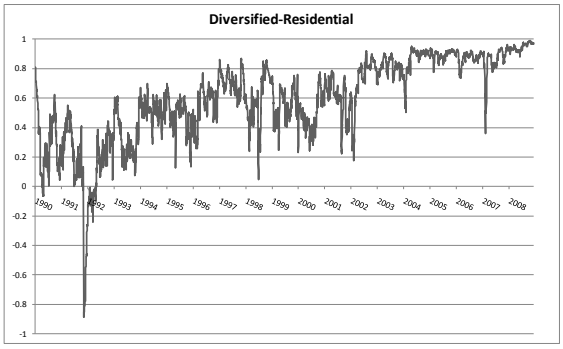

Industrial-Retail

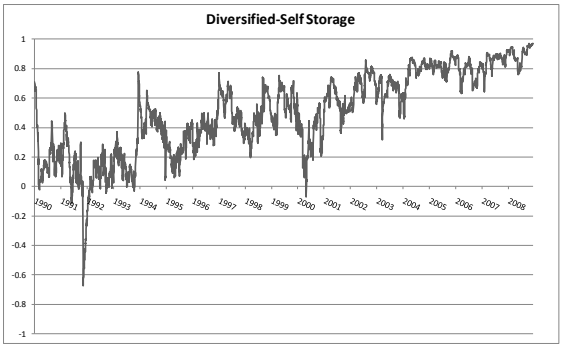

Industrial-Residential

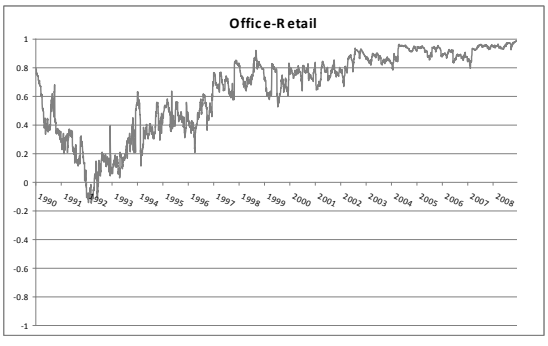

Industrial-Self Storage

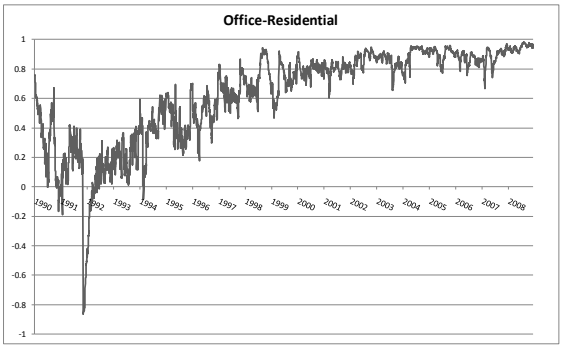

Diversified-Office

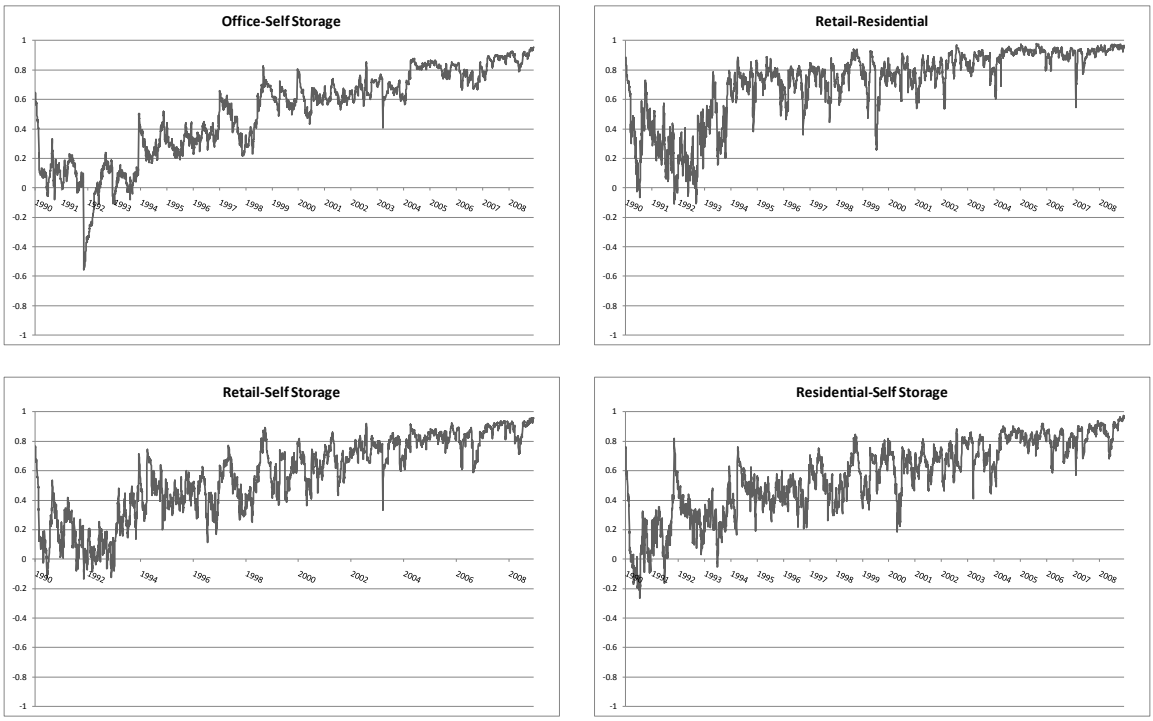

Diversified-Retail


Diversified-Residential


Diversified-Self Storage


Office-Retail


Office-Residential



Note: Figure 1 graphically displays the conditional correlation coefficients, as estimated using the GARCH-DCC (1,1) procedure, for each pairing of REIT sub-sectors.

Table 4: Summary Statistics of Conditional Correlations

	Average	Minimum	Maximum	Standard Deviation	Trend (x 1,000)	T-Ratio	R-Squared
Healthcare-Hotel/Lodging	0.4379	-0.1108	0.9415	0.2791	0.1852	156.6215***	0.8371
Healthcare-Industrial	0.5093	-0.2052	0.9303	0.2718	0.1747	132.4035***	0.7859
Healthcare-Diversified	0.5575	-0.0107	0.9656	0.2445	0.1510	112.3028***	0.7254
Healthcare-Office	0.5167	-0.1444	0.9590	0.2821	0.1788	124.1094***	0.7633
Healthcare-Retail	0.6170	-0.0851	0.9552	0.2258	0.1380	108.9503***	0.7131
Healthcare-Residential	0.5741	-0.6843	0.9782	0.2575	0.1533	99.2140***	0.6733
Healthcare-Self Storage	0.4626	-0.4564	0.9586	0.2817	0.1820	135.5601***	0.7937
Hotel/Lodging-Industrial	0.4634	-0.1434	0.9125	0.2827	0.1866	151.6822***	0.8281
Hotel/Lodging-Diversified	0.4739	-0.2112	0.9587	0.2990	0.1833	109.3887***	0.7148
Hotel/Lodging-Office	0.4888	-0.2290	0.9540	0.3028	0.1957	135.4392***	0.7934
Hotel/Lodging-Retail	0.5166	-0.1446	0.9510	0.2837	0.1865	148.0132***	0.8210
Hotel/Lodging-Residential	0.4669	-0.7267	0.9648	0.3173	0.2034	130.4727***	0.7809
Hotel/Lodging-Self Storage	0.3892	-0.4386	0.9478	0.2916	0.1894	138.9903***	0.8018
Industrial-Diversified	0.5579	-0.1924	0.9499	0.2765	0.1711	112.9975***	0.7278
Industrial-Office	0.5749	-0.1934	0.9636	0.3196	0.2053	131.8933***	0.7846
Industrial-Retail	0.6395	-0.0092	0.9658	0.2618	0.1709	142.6710***	0.8100
Industrial-Residential	0.6219	-0.7614	0.9660	0.2890	0.1805	117.0350***	0.7415
Industrial-Self Storage	0.5187	-0.3972	0.9254	0.2650	0.1758	156.3712***	0.8366
Diversified-Office	0.5878	-0.2297	0.9833	0.2755	0.1697	111.1886***	0.7214
Diversified-Retail	0.6487	-0.0481	0.9804	0.2365	0.1404	98.5050***	0.6702
Diversified-Residential	0.5973	-0.8861	0.9910	0.2822	0.1627	90.5300***	0.6318
Diversified-Self Storage	0.5016	-0.6722	0.9726	0.2848	0.1775	116.0429***	0.7382
Office-Retail	0.6475	-0.1463	0.9884	0.2797	0.1762	121.1525***	0.7545
Office-Residential	0.6263	-0.8645	0.9807	0.3178	0.1937	107.1841***	0.7064
Office-Self Storage	0.4972	-0.5564	0.9548	0.3010	0.1982	149.6273***	0.8242
Retail-Residential	0.7153	-0.1094	0.9780	0.2387	0.1347	85.5653***	0.6052
Retail-Self Storage	0.5677	-0.1363	0.9601	0.2646	0.1677	124.3471***	0.7640
Residential-Self Storage	0.5672	-0.2625	0.9733	0.2500	0.1562	117.1072***	0.7417

Note: "Trend" is the slope coefficient of a regression of conditional correlations on a constant and a time trend. * indicates significance at the 10% level, ** at the 5% level and *** at the 1% level. The sample covers the period January 1990 to December 2008.

Table 5: Modeling Conditional Correlations and Volatility

	Intercept		REIT Volatility		R-Squared
	Coefficient	t-statistic	Coefficient	t-statistic	
Healthcare-Hotel/Lodging	-0.0980	-10.6418***	6.1170	61.5733***	0.4425
Healthcare-Industrial	0.0024	0.2669	5.7845	58.5051***	0.4175
Healthcare-Diversified	0.0934	11.4740***	5.2962	60.3311***	0.4325
Healthcare-Office	-0.0117	-1.2364	6.0302	58.9326***	0.4210
Healthcare-Retail	0.2075	26.7297***	4.6732	55.8149***	0.3948
Healthcare-Residential	0.1554	16.5208***	4.7792	47.1242***	0.3173
Healthcare-Self Storage	-0.0634	-6.6806***	6.0030	58.6303***	0.4185
Hotel/Lodging-Industrial	-0.0543	-5.6193***	5.9080	56.7265***	0.4025
Hotel/Lodging-Diversified	-0.0826	-8.1819***	6.3511	58.3135***	0.4159
Hotel/Lodging-Office	-0.0509	-4.8373***	6.1602	54.2553***	0.3813
Hotel/Lodging-Retail	0.0083	0.8459	5.8009	54.7058***	0.3852
Hotel/Lodging-Residential	-0.0561	-4.8727***	5.9692	48.0809***	0.3261
Hotel/Lodging-Self Storage	-0.1621	-16.6477***	6.2928	59.9137***	0.4291
Industrial-Diversified	0.0677	7.0176***	5.5950	53.7950***	0.3773
Industrial-Office	0.0503	4.3318***	5.9871	47.7778***	0.3233
Industrial-Retail	0.2220	23.0158***	4.7647	45.8015***	0.3051
Industrial-Residential	0.2223	19.8214***	4.5609	37.7118***	0.2294
Industrial-Self Storage	0.0769	8.0406***	5.0424	48.8835***	0.3334
Diversified-Office	0.0874	9.2334***	5.7105	55.9391***	0.3958
Diversified-Retail	0.2421	28.8252***	4.6405	51.2400***	0.3547
Diversified-Residential	0.1613	15.3079***	4.9754	43.7874***	0.2864
Diversified-Self Storage	0.0078	0.7715	5.6362	51.9256***	0.3608
Office-Retail	0.2026	19.6354***	5.0778	45.6419***	0.3036
Office-Residential	0.1824	14.8360***	5.0669	38.2267***	0.2342
Office-Self Storage	-0.0074	-0.6832	5.7592	49.3187***	0.3374
Retail-Residential	0.3862	41.6504***	3.7559	37.5673***	0.2280
Retail-Self Storage	0.1205	12.7128***	5.1041	49.9322***	0.3429
Residential-Self Storage	0.1287	14.6642***	5.0037	52.8616***	0.3691

Note: The results are obtained from estimating the regression $\rho_t = \alpha + \beta_R \sqrt{h_{R,t}} + \varepsilon_t$. The conditional volatilities and covariances are calculated as the fitted values. The conditional correlations are measured as the ratio of the conditional covariances to the product of the conditional volatilities. $\overline{R}^2$ is the adjusted coefficient of determination statistic. * indicates significance at the 10% level, ** at the 5% level and *** at the 1% level. The sample covers the period January 1990 to December 2008. The sample covers the period January 1990 to December 2008.

Endnotes:

[1] The Omnibus Budget Reconciliation Act increased the attractiveness of institutional investment in REITs while the UPREIT structure allowed real estate investors to effectively defer capital gains tax liabilities when establishing a REIT.

[2] This paper focuses upon what are referred to as Equity REITs and are those firms that invest in the private real estate market. In addition, there are Mortgage REITs which invest in the real estate related debt, including Mortgage Backed Securities. Furthermore, there are some remaining Hybrid REITs that undertake investment in both the equity and debt markets.

[3] The paper by Lin & Yung (2006) utilizes similar data and hence is subject to the same issues. They find no evidence of equity capital flows affecting subsequent REIT returns, although they do find evidence of REIT returns having a significant impact upon future capital flows.

[4] For a comprehensive review of studies of the relationship between Equity REITs and stocks see Case et al. (2010).

[5] See for example, Bradley et al. (1988), Fluck & Lynch (1999) and Kaplan & Weisbach (1992).

[6] Cronqvist et al. (2001) also finds evidence in line with the broader finance literature by linking agency issues with the diversification discount noted. Furthermore, Campbell et al. (2003) argues that the excess returns reported with respect to REIT portfolio acquisitions can be attributed to the signaling effect that the deals send to the market in terms of their continued focused portfolio strategy. The findings of Danielsen & Harrison (2007) also reduces the importance of a common word of caution noted with respect to the Capozza & Seguin (1998, 1999) studies. For both papers the sample period examined ended in 1992, i.e. prior to the beginning of the modern REIT era. It is therefore often been felt that the effect of information asymmetry on liquidity may differ in the post 1992 period. The fact that Danielsen & Harrison (2007) find supporting evidence with respect to REIT spreads does imply that the arguments still stand.

[7] Ro & Ziobrowski (2010) do however find evidence of significant differences in the systematic risk of the samples. In contrast though, using an international sample, Boer et al. (2005) report that the corporate focus/specialization of listed real estate firms does not affect the systematic risk of the firms.

[8] More detailed indices are available for the retail and residential sectors. For example, retail is divided into specific property types such as shopping centers. The empirical analysis was also conducted with these indices and these results are available from the authors. The results with respect to the more detailed indices do not fundamentally differ when compared to other sectors. When the tests were run within either retail or residential, as one would expect, the results show far higher conditional correlations. However, given that the focus of the study is concerned with the broader sector splits only the overall results for retail and residential are provided.

[9] Early versions of this paper did model the conditional correlations using the BEKK approach. The analysis in this version of the paper ran from 1990 to June 2006. The results are available from the authors and do not differ substantially from those contained in this version.

[10] As Case et al. (2010) note an important issue in any analysis of REITs is the data frequency adopted. The use of daily data in the current study does mean that the analysis is undertaken with share prices more prone to market shocks and sentiment issues. It is possible that if the analysis were to be undertaken with lower frequency data then the patterns observed would not be as distinct.

[11] While the proportion of the REIT sector held by dedicated REIT mutual funds has indeed increased, it does not account for the full increase in institutional ownership, as the figures reported in Lin et al. (2009) and Hartzell et al. (2010) illustrate.