EDHEC-Risk Institute

393-400 promenade des Anglais
06202 Nice Cedex 3
Tel.: +33 (0)4 93 18 32 53
E-mail: research@edhec-risk.com
Web: www.edhec-risk.com

Conditional Correlations and Real Estate Investment Trusts

June 2008

James Chong
California State University-Northridge

Joëlle Miffre
EDHEC Business School

Simon Stevenson
Cass Business School, City University

EDHEC BUSINESS SCHOOL

Abstract

The paper studies the temporal variations in the conditional correlations between REIT returns and equity, bond and commodity returns. While REITs are often presented as useful tools for diversification, little is known of the way their returns correlate with the returns of other asset classes over time and in periods of high volatility. This paper addresses this issue and draws two conclusions. First, the correlations between REITs and equity returns rose over the period analyzed, while the correlations with bonds and commodities fell. This indicates to equity portfolio managers that real estate has lost some of its diversification properties, but to bond and commodity portfolio managers it has become attractive for strategic asset allocation. Second, the correlations with REITs rose especially in periods of above average volatility in equity and bond markets. This is unfortunate as it is precisely in periods of high volatility that investors need the benefits of diversification the most. There are, however, two noticeable exceptions (for the US government securities and the GSCI), where the conditional correlations with REITs fell in periods of high volatility in these markets. This indicates that to reduce the total risk of their portfolio investors in US government securities and commodities should tilt their asset allocation more towards real estate when they anticipate changes in monetary policy or abnormal fluctuations in commodity prices.

Keywords: Real estate, Equity, Bond, GSCI, Correlations, GARCH-DCC

The paper was presented at the European Real Estate Society Annual Conference, London, June 2007.

EDHEC is one of the top five business schools in France. Its reputation is built on the high quality of its faculty and the privileged relationship with professionals that the school has cultivated since its establishment in 1906. EDHEC Business School has decided to draw on its extensive knowledge of the professional environment and has therefore focused its research on themes that satisfy the needs of professionals.

EDHEC pursues an active research policy in the field of finance. EDHEC-Risk Institute carries out numerous research programmes in the areas of asset allocation and risk management in both the traditional and alternative investment universes.

I. Introduction

The relationship between real estate investment Trusts (REITs) and the broader capital markets is one of ongoing interest. The possible diversification opportunities available from REITs, from the perspective of both equity and fixed income portfolios, have been examined in a wide variety of both academic and industry research. Obviously the relationship between REITs and alternative asset classes is of importance from a fund manager's perspective. However, due to the changing nature of the REIT market the stability of these relationships and how they have altered during the recent past is also of paramount importance. From the mid-nineties onwards there has been a marked increase in investor awareness. As Chan *et al.* (1998) note, institutional investment increased substantially in the 1990's and a positive relationship exists between this and REIT performance. This process has continued and the inclusion of REITs in the Standard & Poor's indices in 2001 was a further step in increased investor acceptance of the sector.

The paper studies the conditional correlation structure in the REIT sector. In particular, the conditional correlations of REITs are estimated against a variety of equity, bond and commodity series. The paper builds upon recent work in the REIT literature that examines the dynamics of the sector. The data used in this paper consists of daily returns for the period January 1, 1990, through December 30, 2005, totaling 4,000 observations. During this time, the popularity of REITs has expanded dramatically with massive growth in investor awareness and interest focusing on the return and volatility characteristics of the sector. The analysis is conducted using the dynamic conditional correlation model of Engle (2002), whereby the conditional correlations are estimated against a variety of equity, bond and commodity sectors. Domestic equity sectors representing large capitalization, small capitalization, value and growth stocks are analyzed together with international equity markets. Bonds of different maturities and countries of issuance are also considered. For the sake of completeness and given the growing interest of portfolio managers in commodities, the GSCI (Goldman Sachs Commodity Index) is also used as one of the asset classes against which the correlation with REITs is measured.

The results reveal that over the sixteen-year sample there is a high level of instability in the conditional correlations. As would be expected the conditional correlations with respect to the domestic equity sectors are largely higher than either the US fixed income or foreign stock and bond markets. However, distinct phases in the correlations are observable. While the correlations are generally close to zero, there are periods when substantial increases in the relationships observed are noticed. These time variations in the conditional correlations are subject to two systematic patterns. First, we observe that the conditional correlations with equity returns rose over the period analyzed, while that with bond and commodity returns fell. This indicates that real estate has lost some of its luster for strategic asset allocation to equity portfolio managers but has gained part of its diversification properties to bond portfolio managers and CTAs over time. Second, the correlations with REITs rose especially in periods of above average volatility in equity and bond markets. This is unfortunate as it is precisely in periods of high volatility in the bond and equity markets that investors need the benefits of diversification the most. There are, however, two noticeable exceptions (for the US government securities and the GSCI), where the conditional correlations with REITs fell in periods of high volatility. This indicates that to reduce the total risk of their portfolio investors in US government securities and commodities should tilt their asset allocation more towards real estate when they anticipate changes in monetary policy or abnormal fluctuations in commodity prices.

The rest of the paper is organized as follows. Section II reviews the literature on the relationship between REITs and the broader capital markets. Sections III and IV presents the methodological framework and the data, respectively. Section V analyzes the temporal variations in the conditional correlations between REITs returns on the one hand and equity, bond and commodity returns on the other. Finally, section VI highlights the main conclusions of the paper.

II. Literature Review

A number of recent papers have illustrated the diversification opportunities that REITs can provide, from the perspective of both a real estate portfolio and from a capital market portfolio. Feldman (2003) finds that both public and private real estate have a place in a mixed-asset framework. Mueller and Mueller (2003) extend the analysis of Feldman (2003) to examine the impact of private and public real estate on the mixed-asset portfolio for various holding periods. The authors find that for the full sample period, the inclusion of private real estate as measured by the NCREIF index, either appraisal based or de-smoothed, led to improvements in the performance of the efficient frontier at the lower risk levels, while REITs provided improvements to the entire frontier. A result supported by the findings for the 5- to 15-year sub-periods. Lee and Stevenson (2005) examine the consistency of REITs within a capital market mixed-asset framework. The results show that REITs consistently provide diversification benefits to the mixed-asset portfolio, with substantial allocations in the efficient portfolios. In the low risk/return portfolios, the allocations obtained in the return enhancement tests are larger than those when examining risk reduction. This trend, however, reverses as one moves up the efficient frontier. This would indicate that as an investor moves along the frontier the rationale for the inclusion of REITs alters, with increasing emphasis being placed on the assets' risk reduction qualities rather than its return enhancing capabilities.

Any analysis of performance in the US REIT sector has to take into account the structural changes in the market. The combination of factors such as the 1986 Tax Reform Act, the impact of the early nineties cycle and the introduction of the UPREIT (Umbrella Partnership REIT) structure heralded a new era for the REIT sector. Many empirical studies have shown that the characteristics of the sector changed quite substantially in subsequent years. For example, Glascock *et al.* (2000) found that, from 1972 to 1991, REITs were segmented from the broader equity market, but were integrated from 1992. In addition, the authors find that prior to 1992, the returns of both Equity and Mortgage REITs behaved in a fashion more similar to the fixed-income market, but that the Equity REIT sector acted more like stocks post 1992. Clayton and MacKinnon (2001) note that the correlation of REIT returns with stocks and bonds underwent a structural change in the 1990s, with the sensitivity of REIT returns to large-cap stocks declining over time, while that with small-cap stocks increased. This is a finding that has been observed in a large number of studies (*e.g.* Chiang and Lee, 2002; Ziering *et al.*, 1999). Clayton and MacKinnon (2001) argue that their finding relating to the changing relationships with the broader equity markets can at least in part be attributed to the growing maturity of the REIT sector. This growing maturity can be illustrated by the level of trading in REIT shares. In 1993 SNL Financial estimates that the average daily aggregate volume in the sector was 3 million shares. By 2005, this figure had increased to over 40 million.

This paper also builds upon recent work in the REIT literature to have examined the volatility dynamics of the sector. Stevenson (2002) examined volatility spillovers using monthly data within both different REIT sectors and between REITs and the equity and fixed-income markets. Winniford (2003) finds strong evidence that volatility in Equity REITs varies on a seasonal basis, with observed increased volatility in April, June, September, October and November. Najand and Lin (2004) utilize both GARCH (generalized autoregressive conditional heteroskedasticity) and GARCH-in-mean models in their analysis, reporting that volatility shocks are persistent, while Cotter and Stevenson (2008) find that increased trading volume is an important determinant in the increase in REIT volatility. A number of papers have extended the analysis of volatility spillovers and dynamics into an international context, for example, Liow et al. (2008) and Michayluk *et al.* (2006). 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. It is this paper that the current study most closely resembles. While Cotter and Stevenson (2006) estimate the conditional correlations the period examined is highly specific. The current study

extends the sample, and also the assets against which REITs are compared, to sixteen years and detects for the first time some systematic patterns in the conditional correlations between real estate returns on the one hand and the returns from the capital, money and commodity markets on the other hand.

III. Methodological Framework

By far the most successful volatility forecasting model is the GARCH(1,1) (Hansen and Lunde, 2005), developed by Bollerslev (1986). It describes the volatility dynamics of almost any financial return series, across markets and asset groups (Engle, 2004). The GARCH(1,1) variance, $h_{ii,t}$, is represented by

$$x_{i,t} = \mu + \varepsilon_{i,t},\ \varepsilon_{i,t} \sim N(0, h_{ii,t}),$$

$$h_{ii,t} = \gamma_i + \alpha_i \varepsilon_{i,t-1}^2 + \beta_i h_{ii,t-1} \qquad i = 1,\ldots,N$$

subject to $\gamma_i > 0, \alpha_i, \beta_i \geq 0, \alpha_i + \beta_i < 1$. 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.

In estimating the conditional correlation, we employ the dynamic conditional correlation (DCC) model of Engle (2002). Upon estimating the GARCH(1,1) model and employing its resulting standardized residuals, a time-varying correlation matrix is estimated via the DCC(1,1). Hence, the covariance matrix can be expressed as $H_t \equiv D_t R_t D_t$, where $D_t = diag\left(h_{11,t}^{1/2} \ldots h_{NN,t}^{1/2}\right)$ 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 $Q_t = (q_{ij,t})$ as described by

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

$\overline{Q}$ is the $N \times N$ unconditional covariance matrix of standardized residuals, $\Xi_t = x_t / \sqrt{h_t}$ resulting from the first stage estimation, $Q_t^* = \left(q_{ii,t}^*\right) = \left(\sqrt{q_{ii,t}}\right)$ is a diagonal matrix composed of the square root of the ith diagonal elements of Q_t, and a and b are non-negative coefficients satisfying $a + b < 1$. Rewriting $R_t = Q_t^{*-1} Q_t Q_t^{*-1}$, the conditional correlation between assets i and j at time t can then be expressed as $\rho_{ij,t} = \frac{q_{ij,t}}{\sqrt{q_{ii,t} q_{jj,t}}}$.

As with the GARCH(1,1) model, 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, is

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

with $H_t = E_{t-1}\left(\Xi_t \Xi_t'\right)$ being the $N \times N$ conditional variance/covariance matrix.

We can use the framework presented above to analyze the conditional correlations between REITs returns and the returns of traditional asset classes. First, we investigate how they changed over time by simply regressing them on a constant and a time trend. Second, we study the relation between conditional correlations and conditional volatilities by regressing the former on the latter as follows:

$$\rho_t = \alpha + \beta_{NR}\sqrt{h_{NR,t}} + \beta_R \sqrt{h_{R,t}} + \varepsilon_t \qquad (1)$$

where the subscripts *NR* and *R* refer to non-REITs and REITs, respectively. Taking the S&P500 index as an example, a positive β_{NR} would suggest that conditional return correlations between the S&P500 index and REITs rise with the volatility of equity markets. If so, the evidence from international stock markets (Solnik *et al.*, 1996; Longin and Solnik, 2001) can be extrapolated to equity and

real estate markets. On the other hand, a negative β_{NR} would indicate that correlations between real estate and equity returns fall in periods of high volatility in equity markets. Ultimately, this result would imply that the usefulness of real estate as a diversification tool increases in periods of above average market volatility; suggesting that the diversification sought after by investing in real estate is most present when most needed.

IV. Data

The REIT data used is the SNL Financial Equity REIT Index, while the bonds, equities and commodities data (hereafter referred to as non-REITs data) is obtained from Datastream. The choice of the equity and bond indices was dictated by the fact that they represent a substantial proportion of the asset allocation of a well-diversified asset manager. Based on this criterion eight equity asset classes (four from the US and four from global markets) were shortlisted. They are the S&P500 composite index, the Russell 2000 Index, the Russell 1000 Value Index, the Russell 1000 Growth Index, the MSCI Europe Index, the MSCI Asia Pacific Index, the MSCI Latin America Index and the MSCI North America Index. When it comes to fixed income markets, we concentrate our attention on six bond indices from J.P. Morgan: United States Government Securities, US Cash with six-month maturity, US Cash with twelve-month maturity, Global Asia, Global Africa and Global Europe. The GSCI is used as a proxy for the commodity market.[1] The frequency of the data is daily. Bank holidays are excluded. The sample covers the period 2 January 1990 to 31 December 2005 for most series, totaling 4,000 observations. For the series with relatively fewer observations, the details of the starting dates are reported in table 1.

Table 1: Summary Statistics of Returns

	Starting Date	Mean	Standard Deviation	Reward-to-Risk Ratio	Skewness	Excess Kurtosis	Jarque Bera Test	Correlation with REITs
Panel A: REITs								
REITs	1-Jan-90	0.0901 *	0.1173	0.7679	-0.3402 *	5.5324 *	5177.11 *	
Panel B: Equity Asset Class								
S&P500	1-Jan-90	0.0919 **	0.1611	0.5703	0.0062	3.7133 *	2297.53 *	0.4949 *
Russell 2000 Small Cap	1-Jan-90	0.1010 **	0.1689	0.5980	-0.2525 *	2.9821 *	1524.26 *	0.5771 *
Russell 1000 Value	2-Jan-91	0.1073 *	0.1440	0.7451	-0.0526	3.8662 *	2336.07 *	0.5421 *
Russell 1000 Growth	2-Jan-91	0.1008 **	0.1921	0.5247	0.1786 *	5.1742 *	4200.79 *	0.4498 *
MSCI Europe	1-Jan-90	0.0793 ***	0.1614	0.4911	-0.2470 *	3.9166 *	2596.63 *	0.3047 *
MSCI Asia Pacific	1-Jan-90	0.0126	0.1984	0.0637	0.3153 *	4.6577 *	3680.98 *	0.1057 *
MSCI Latin America	1-Jan-90	0.1654 **	0.2510	0.6590	-0.1463 *	8.9808 *	13453.31 *	0.2862 *
MSCI North America	1-Jan-90	0.0922 **	0.1582	0.5829	-0.0178	3.8304 *	2444.98 *	0.4968 *
Equity Average		0.0938	0.1794	0.5229	-0.0270	4.6402	4066.82	0.4072
Panel C: JPM Fixed Income Asset Class								
US Government	1-Jan-90	0.0704 *	0.0451	1.5585	-0.2909 *	1.9086 *	663.36 *	0.0424 *
US Cash with 6-month maturity	1-Jan-90	0.0490 *	0.0040	12.2070	1.4887 *	8.1593 *	12569.98 *	0.0305 ***
US Cash with 12-month maturity	1-Jan-90	0.0533 *	0.0085	6.2943	0.5084 *	5.5789 *	5358.36 *	0.0316 **
Global Asia Pacific	31-Dec-93	0.0883 *	0.0644	1.3716	-1.8380 *	25.4073 *	82325.76 *	0.1464 *
Global Africa	31-Dec-93	0.1367 *	0.1436	0.9519	-1.4901 *	19.8190 *	50175.78 *	0.1307 *
Global Europe	31-Dec-93	0.1585 *	0.1862	0.8515	-1.2876 *	16.4269 *	34536.51 *	0.1619 *
Bond Average		0.0927	0.0753	3.8725	-0.4849	12.8833	30938.29	0.0906
Panel D: Commodities								
GSCI	1-May-97	0.0946	0.2149	0.4404	-0.0613	1.2438 *	140.90 *	-0.0437 **

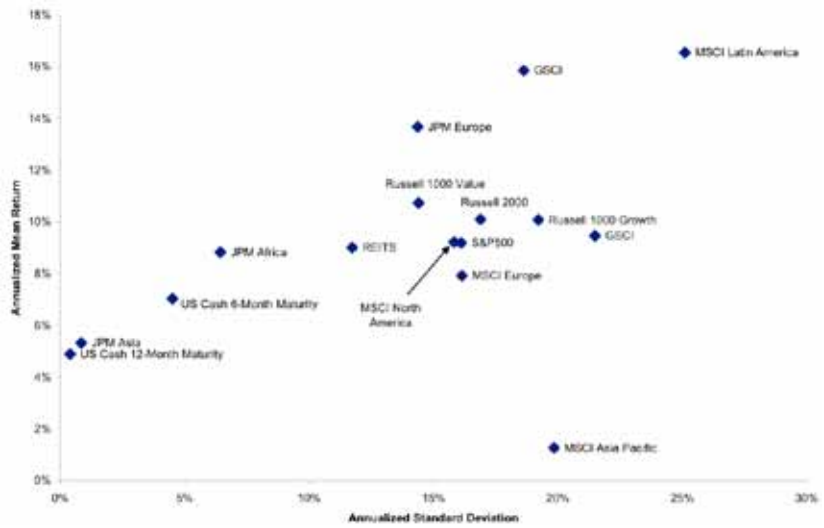
Note: The mean and standard deviation are annualized. The reward-to-risk ratio is measured as the ratio of the annualized mean to the annualized standard deviation. Pearson correlation test is used to measure the significance of correlation. *, ** and *** indicate significance at the 1, 5 and 10% levels, respectively. The sample ends in December 2005.

Table 1 also presents summary statistics for the REITs, equity, bond and commodity returns. Figure 1 plots the average annualized standard-deviation of each series against its annualized mean return. On balance, the REITs index appears to present both desirable and undesirable properties to investors. When compared to equities in Panel B, the reward-to-risk ratio of REITs exceeds that of all equity indices and its correlation with equity indices, albeit significant at the 1% level, is rather low with a range from 0.1057 (with the MSCI Asia Pacific Index) to 0.5771 (with the Russell 2000

1 - To compile futures prices into a series of futures return, we collect the settlement prices on the nearest maturity futures contract, except in the maturity month when the price on the second nearest futures is used. Futures returns are then computed as the percentage change in these settlement prices.

Small Cap Index). Relative to bonds in Panel C, the REITs index performs worse on a risk-adjusted basis with a reward-to-risk ratio that is consistently less than that of bonds. Of note, however, is the fact that all three global bond indices present disproportionate negative skewness and extreme positive excess kurtosis. The seemingly undesirable risk-return trade-off of REITs relative to bonds has thus to be weighed against the fact that many bonds in the J.P. Morgan Europe, Africa and Asia-Pacific indices defaulted over the period considered, causing undesirable negative skewness and positive excess kurtosis in their return distributions. Given investors' preferences for positive skewness and platykurtic distributions and the importance of higher moments in asset pricing (Kraus and Litzenberger, 1976; Harvey and Siddique, 2000; Chung *et al.*, 2006), the superior risk-adjusted performance of the bond indices could well be a compensation for exposure to such an undesirable distribution. Should higher moments be taken into account, the REIT index, in spite of its negative skewness, could become more attractive to risk-averse investors than the J.P. Morgan Asia Pacific, Africa and Europe bond indices. With an average at 0.0906 and a range of 0.0305 (with US six-month maturity cash) to 0.1619 (with J.P. Morgan Global Europe), the correlations between the REITs and bonds returns are low, making the REITs index an useful tool for risk diversification and strategic asset allocation. When compared to the GSCI index in Panel D, the REITs index has a similar mean return to that of the GSCI index for a standard deviation that is 54% less than that of the commodity index. The average correlation between the REITs and GSCI indices is also found to be low and negative at the 5% level.

Figure 1 – Risk and Return Trade-off



V. Empirical Results

This section looks at the temporal variation in the conditional correlations between REIT returns on the one hand and equity, bond and commodity returns on the other. Table 2 presents summary statistics of the conditional correlations between REITs and non-REITs returns as estimated from our bivariate GARCH-DCC model. The results warrant three comments. First, the average conditional correlations (0.4067 for equities, 0.1083 for bonds and -0.0414 for commodities) in Table 2 are similar to the average unconditional correlation (0.4072, 0.0906 and -0.0437, respectively) reported in Table 1. As in Table 1, the conditional correlations in Table 2 are significant at the 1% level. Second, there is sizeable divergence in the volatilities of the conditional correlations, with standard deviations ranging from 3.72% for US Cash with twelve-month maturity to 24.37% for US Treasury-bonds. Third, and possibly most importantly, regressions of conditional correlations on a time trend reveal a rise over time in the conditional correlations between REITs returns and the returns of most equity indices at the 1% level, the exceptions being the MSCI Europe and Asia Pacific indices. The opposite applies to bonds and commodities, for which the coefficients on the

time trend are systematically negative at the 1% level. This suggests that over time, the real estate market has become more integrated with the equity market and more segmented from the bond and commodity markets. As a result, the diversification properties of REITs have decreased from the perspective of an equity asset manager but the importance of real estate for strategic asset allocation has increased from the perspective of a bond portfolio manager or a CTA.

The change in correlation, measured as $\Delta\rho$[2] in Table 2, is significant in economic terms too. With the exceptions of MSCI Europe and MSCI Asia Pacific, the conditional correlations with equities have increased over the samples considered by 1.48% a year. In contrast, the conditional correlations with bonds have decreased by an average of -6.66% a year. The increase in correlation is particularly strong for the MSCI Latin America and the MSCI North America indices that witnessed yearly rises in correlations with the REITs index of 2.82% and 2.37%, respectively. At the other end of the spectrum, the correlations with all six bond indices have fallen dramatically, with the decrease in correlations ranging from -8.97% (J.P. Morgan Global Asia Pacific) to -4.25% (J.P. Morgan Global Europe) a year. The strongest decrease in correlations is for the GSCI (-19.71% a year).

Table 2: Summary Statistics of Conditional Correlations

	Average	Standard Deviation	Trend (*1,000)	*t*-ratio	$\overline{R}^2$	$\Delta\rho$
Panel A: Equity Asset Class						
S&P500	0.4913 *	0.1157	0.0207	14.91	4.23%	1.15%
Russell 2000 Small Cap	0.5769 *	0.1252	0.0099	6.32	0.81%	0.45%
Russell 1000 Value	0.5369 *	0.0880	0.0286	25.70	12.33%	1.48%
Russell 1000 Growth	0.4652 *	0.1404	0.0109	6.35	0.68%	0.61%
MSCI Europe	0.2969 *	0.0747	0.0013	1.23	0.02%	0.11%
MSCI Asia Pacific	0.1066 *	0.0789	-0.0176	-16.53	6.64%	-3.11%
MSCI Latin America	0.2907 *	0.1096	0.0268	19.20	7.92%	2.82%
MSCI North America	0.4891 *	0.1733	0.0389	18.88	6.70%	2.37%
Equity Average	0.4067	0.1132	0.0149			0.73%
Panel B: JPM Fixed Income Asset Class						
US Government	0.1068 *	0.2437	-0.0904	-29.87	18.32%	-7.86%
US Cash with 6-month maturity	0.0270 *	0.0558	-0.0145	-16.28	9.03%	-6.48%
US Cash with 12-month maturity	0.0313 *	0.0372	-0.0159	-28.51	24.32%	-6.30%
Global Asia Pacific	0.1528 *	0.2045	-0.1186	-30.35	25.18%	-8.97%
Global Africa	0.1665 *	0.1296	-0.0645	-26.78	18.50%	-6.12%
Global Europe	0.1658 *	0.1217	-0.0378	-17.82	7.21%	-4.25%
Bond Average	0.1083	0.1321	-0.0570			-6.66%
Panel C: Commodities						
GSCI	-0.0414 *	0.0497	-0.0176	-11.87	4.87%	-19.71%

Note: "Trend" is the slope coefficient of a regression of conditional correlations r_t on a constant and a time trend. D*r* is the difference between the last and first fitted values of a regression of conditional correlations on a constant and a zero-mean time trend. * indicates significance at the 1% level. The sample covers the period January 1990 to December 2005.

Table 3 looks at the relation between (a) the conditional correlations between REITs and non-REITs returns and (b) the conditional volatility of the markets. With the exception of US Treasury-bonds and the GSCI, all coefficients on the non-REITs conditional volatilities (β_{NR} in equation (1)) are positive and significant at the 1% or 10% level.[3] Clearly, the correlation between REITs returns and equity returns rises in periods of high volatility in the equity market. Similarly, and with the notable exception of US government securities, the correlation between REITs and bond returns rises in periods of high interest rate volatility. This is disappointing news to investors who use real estate securities as part of their strategic asset allocation as it is precisely when the volatility of the equity and bond markets is high that the benefits of diversification are most needed.[4]

2 - Conditional correlations are regressed on a constant and a zero-mean time trend. For each equity index, $\Delta\rho_{SF}$, the difference between the last and first fitted values, measures the amount by which the correlations have decreased or increased over the period analyzed.

3 - Similar results are obtained when the volatility of non-REITs returns is used as the only independent variable in Equation (1). The results are available from the authors upon request.

4 - Since the explanatory power of the model is, at times, low and the constant in Equation (1) is almost always significant, it is noted that conditional volatilities may not be the only drivers of conditional correlations.

Table 3: The Relation between Conditional Correlation and Conditional Volatility

	Intercept		Non–REIT Volatility: $\sqrt{h}_{NR,t}$		REIT Volatility: $\sqrt{h}_{R,t}$		$\overline{R}^2$
	α	$t(\alpha)$	β_{NR}	$t(\beta_{NR})$	β_R	$t(\beta_R)$	
Panel A: Equity Asset Class							
S&P500	0.3745	85.59	10.3800	21.17	2.5067	3.00	13.42%
Russell 2000 Small Cap	0.4873	94.06	4.2079	5.35	6.9148	5.88	7.54%
Russell 1000 Value	0.4213	120.59	11.5083	23.00	2.5042	3.50	21.77%
Russell 1000 Growth	0.3965	67.69	3.2603	7.83	4.6908	4.92	3.24%
MSCI Europe	0.2058	55.91	12.1108	36.63	-3.7189	-8.02	25.50%
MSCI Asia Pacific	0.0490	7.85	6.0572	14.65	-2.2381	-3.71	9.32%
MSCI Latin America	0.2410	36.10	0.7919	1.82	5.4242	7.45	2.62%
MSCI North America	0.3214	47.12	13.6076	18.72	5.6776	4.80	12.11%
Panel B: JPM Fixed Income Asset Class							
US Government	0.7345	40.74	-191.8477	-28.68	-12.3471	-8.79	23.24%
US Cash with 6-month maturity	-0.0355	-7.88	259.4536	21.37	-0.0756	-0.18	17.23%
US Cash with 12-month maturity	-0.0042	-1.30	86.1888	17.75	-1.3146	-5.21	13.04%
Global Asia Pacific	0.1891	18.04	21.1438	11.49	-15.6100	-12.41	9.12%
Global Africa	0.1940	29.93	2.4942	7.13	-6.5653	-10.79	4.22%
Global Europe	0.1313	18.06	3.8157	8.26	-0.4929	-0.64	6.39%
Panel C: Commodities							
GSCI	0.0550	5.79	-8.5497	-12.44	2.4807	6.26	12.51%

Note: The results are derived by estimating the regression $\rho_t = \alpha + \beta_{NR}\sqrt{h_{NRt}} + \beta_R\sqrt{h_{R,t}} + \varepsilon_t$. 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. The sample covers period January 1990 to December 2005.

Take, for example, Figure 2, where we plot the conditional correlations between REITs returns and the S&P500 returns against the conditional volatilities of the S&P500 returns. The conditional correlation increases when the S&P500 volatility experiences a spike. For example, market risk was particularly high on August 28, 1990 (24.38%), October 29, 1997 (35%), September 14, 1998 (37.30%), and October 16, 2002 (40.60%), relative to its long-term average of 15.11%. On these days, the conditional correlations were much higher than average (0.6767, 0.7163, 0.7149, 0.6847, respectively versus an average of 0.4913). Similarly, when S&P500 volatility is particularly low, the conditional correlations tend to be low too as, for example, in 1993-1995 or on September 28, 2000, where both the conditional correlation (0.2796) and the conditional S&P500 volatility (12.13%) were low relative to their long-term averages (0.4913 and 15.11%, respectively). As a result, the correlation between conditional correlations and conditional market volatilities in Figure 2 is high at 0.3624 (t-statistic of 24.58). This implies that REITs possess diversification benefits in times of low market stress but they lose part of their hedging properties in periods of increased market instability. Figure 2 also depicts a straight line that is fitted on the conditional correlations to illustrate how they changed over time. Clearly, the line is upward-sloping, suggesting, as in Table 2, that the correlation between REITs and S&P500 returns rose over the period analyzed.

Of note, however are the different results for the US Treasury-bonds and the GSCI. Table 3 shows that β_{NR} is negative for these series, an indication that the diversification sought after with real estate is particularly high in periods of instability in these two markets. Figure 3 plots the conditional correlations between REITs and US government securities versus interest rate risk, as measured by the conditional volatilities of US government securities. As opposed to Figure 2, the correlation between the two series is negative at -0.4594 (*t*-statistic of -32.70), suggesting that correlations fell in periods of high interest rate volatility. For example, interest rates were highly volatile on October 22, 1998 (6.34%), and December 10, 2001 (8.29%), relative to their long-term average (4.46%). On these days, the conditional correlations at -0.0983 and -0.0737, respectively were much lower than their long-term average (0.1067). The trend in the conditional correlation in Figure 3 is clearly downward-sloping, suggesting as in Table 2 that the conditional correlations have decreased over the period analyzed. Figure 4 plots the same information and

draws the same conclusions for the GSCI (the correlation between conditional correlation and GSCI volatility is as low as -0.3146 with an associated t-statistics of -15.42).

Figure 2 – The Relationship between Conditional Correlations and Conditional Volatility: The Case of the S&P500 Index

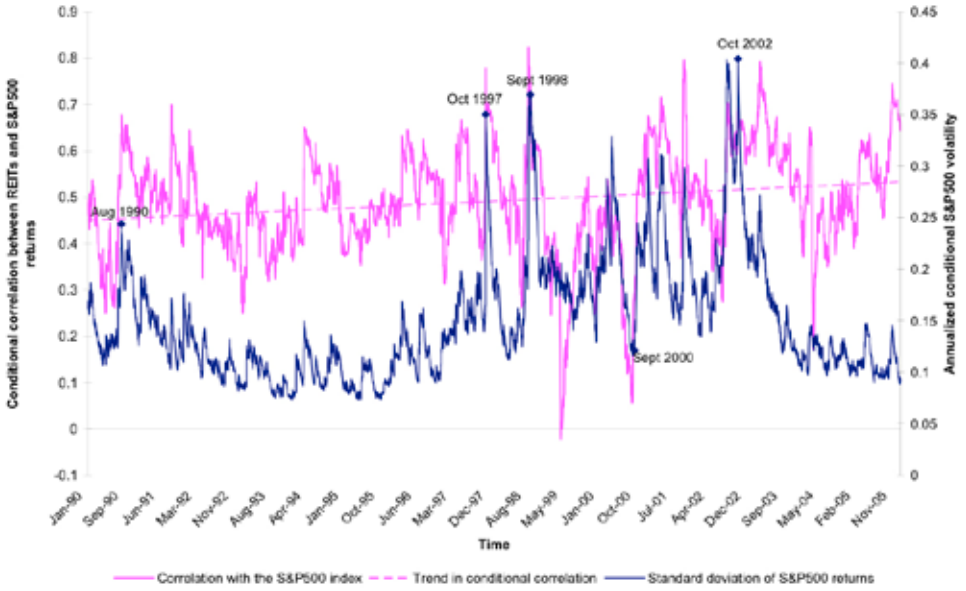


Figure 3 – The Relationship between Conditional Correlations and Conditional Volatility: The Case of the US Treasury-Bond Index

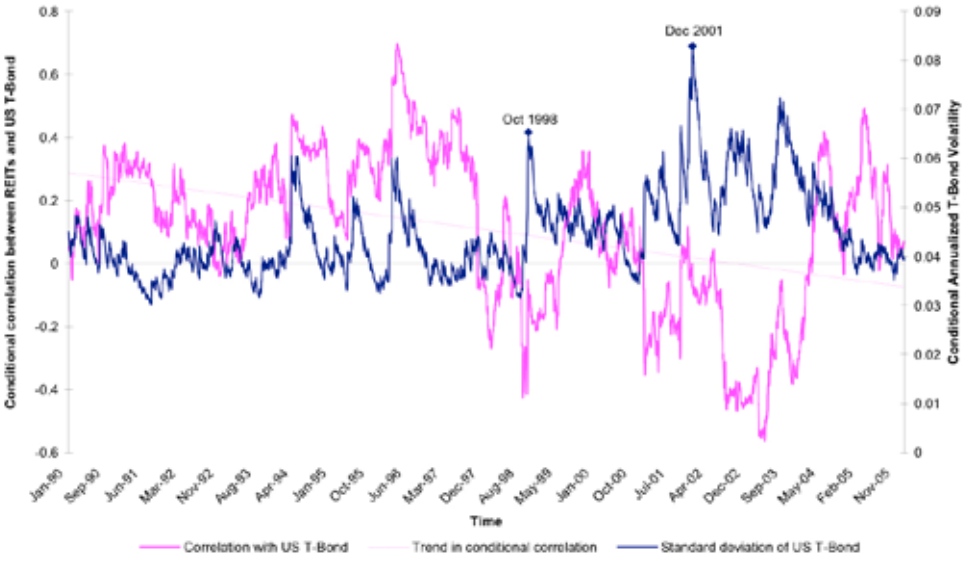
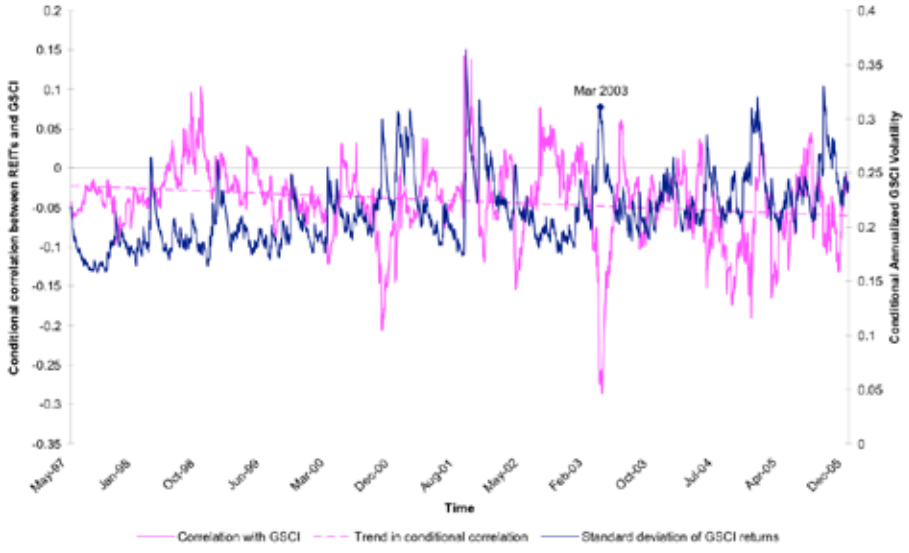


Figure 4 – The Relationship between Conditional Correlations and Conditional Volatility: The Case of the GSCI



These results are good news to bond portfolio managers or GSCI indexers since they indicate that the benefits of diversification are stronger when they are most needed; namely, in periods of high volatilities in these markets. To reduce the total risk of his portfolio a bond or commodity asset manager could tilt his asset allocation more towards real estate when he anticipates changes in monetary policy or abnormal fluctuations in commodity prices. He could in turn use the Vasicek (1977) and Cox, Ingersoll and Ross (1985) models to characterize the behavior of interest rates as a mean reverting process and forecast future interest rates.

VI. Conclusions

A frequently made case for investment in the real estate sector arises from the asset's perceived diversification qualities. However, recent years have seen the sector become increasingly mainstream, with higher levels of trading and changing dynamics in its investment characteristics. To examine some of these issues this paper has estimated the conditional correlations between REITs returns and a variety of equity, bond and commodity indices. Three important issues are emerged from the analysis.

Firstly, we show strong instability in the conditional correlations between REITs and non-REITs returns. Second, the correlations between REITs and equity returns rose over the period analyzed, an indication that the real estate and equity markets have become more integrated and thus that real estate has lost some of its diversification properties relative to equities. However, the correlations between REITs and bond returns or REITs and GSCI returns have decreased since 1990, a sign that the two markets have become more segmented and thus that bond and commodity portfolio managers should use REITs as part of their strategic asset allocation more now than ever before. Third, and perhaps of most interest, the correlations tend to rise during periods of above average volatility, which is precisely when investors would look for diversification benefits the most. With the noteworthy exception of US government securities and the GSCI, the conclusion applies to both equity and bond markets. Of interest, however, is the finding that conditional correlations between US government securities and REITs returns fall in periods of above average interest rate risk, suggesting that a higher allocation towards real estate will reduce portfolio risk in periods of high interest rate volatility. Along the same lines, REITs can be used as a partial hedge against commodity price risk.

References

• Bollerslev, T. (1986). Generalized Autoregressive Conditional Heteroscedasticity, *Journal of Econometrics*, 31, 307-327.

• Chan, S.H., Leung, W.K. and Wang, K. (1998). Institutional Investment in REITs: Evidence and Implications, *Journal of Real Estate Research*, 16, 357-374.

• Chiang, K.C.H. and Lee, M.L. (2002). REITs in the Decentralized Investment Industry, *Journal of Property Investment and Finance*, 20, 496-512

• Chung, P. Y., Johnson, H. and Schill, M. J. (2006). Asset Pricing When Returns Are Non-Normal: Fama-French Factors vs. Higher-Order Systematic Co-Moments, *Journal of Business*, 79, 923-940.

• Clayton, J. and MacKinnon, G. (2001). The Time-Varying Nature of the Link between REIT, Real Estate and Financial Returns, *Journal of Real Estate Portfolio Management*, 7, 43-54.

• Cotter, J. and Stevenson, S. (2006). Multivariate Modeling of Daily REIT Volatility, *Journal of Real Estate Finance and Economics*, 32, 305-325.

• Cotter, J. and Stevenson, S. (2008). Modeling Long Memory in REITs, *Real Estate Economics*, 36, 533-554..

• Cox, J. C., Ingersoll, J. E, and Ross, S. A, (1985). A Theory of the Term Structure of Interest Rates, *Econometrica*, 53 (2), 385-407.

• Engle, R.F. (2002). Dynamic Conditional Correlation: A Simple Class of Multivariate Generalized Autoregressive Conditional Heteroskedasticity Models, *Journal of Business and Economic Statistics*, 20, 339-350.

• Engle, R.F. (2004). Risk and Volatility: Econometric Models and Financial Practice, *American Economic Review*, 94, 405-420

• Feldman, B.E. (2003). Investment Policy for Securitized and Direct Real Estate, *Journal of Portfolio Management*, Special Real Estate Issue, 112-121

• Glascock, J.L., Lu, C. and So, R.W. (2000). Further Evidence on the Integration of REIT, Bond, and Stock Returns, *Journal of Real Estate Finance and Economics*, 20, 1-9

• Hansen, P. R. and Lunde, A., (2005). 'A Forecast Comparison of Volatility Models: Does Anything Beat a GARCH(1,1)? *Journal of Applied Econometrics*, 20, 873-889.

• Harvey, C. R. and Siddique, A. (2000). Conditional Skewness in Asset Pricing Tests, *Journal of Finance*, 55, 1263-1295.

• Kraus, A. and R. Litzenberger (1976). Skewness Preference and the Valuation of Risk Asset, *Journal of Finance*, 31, 1085-1100.

• Lee, S. and Stevenson, S. (2005). The Case for REITs in the Mixed-Asset Portfolio in the Short and Long Run, *Journal of Real Estate Portfolio Management*, 11, 55-80.

• Liow, K., Ho, D., Ibrahim, M. & Chen, Z. (2008). Correlation and Volatility Dynamics in International Real Estate Securities Markets, *Journal of Real Estate Finance and Economics*, forthcoming.

• Longin, F. and Solnik, B. (2001). Extreme Correlation in International Equity Markets. *Journal of Finance*, 56, 649-676.

• Michayluk, D., Wilson, P. & Zurbreugg, R. (2006). Asymmetric Volatility, Correlation and Returns Dynamics Between the US and UK Securitized Real Estate Markets, *Real Estate Economics*, 34, 109-131.

• Mueller, A.G. and Mueller, G.R. (2003). Public and Private Real Estate in the Mixed-Asset Portfolio, *Journal of Real Estate Portfolio Management*, 9, 193-203

• Najand, M. and Lin, C. (2004). Time-Varying Risk Premium for Equity REITs: Evidence from Daily Data, Working Paper, Old Dominion University.

• Solnik, B., Boucrelle, C. and Le Fur, Y. (1996). International Market Correlation and Volatility. *Financial Analysts Journal*, 52, 17-34.

• Stevenson, S. (2002). An Examination of Volatility Spillovers in REIT Returns, *Journal of Real Estate Portfolio Management*, 8, 229-238.

• Vasicek, O. (1977). An Equilibrium Characterization of the Term Structure, *Journal of Financial Economics*, 5 (2), 177-188.

• Winniford, M. (2003). Real Estate Investment Trusts and Seasonal Volatility: A Periodic GARCH Model, Working Paper, Duke University.

• Ziering, B. Liang, D.C. and McIntosh, W. (1999). REIT Correlations with Capital Market Indexes: Separating Signal from Noise, *Real Estate Finance*, 15, 61-67.