Idiosyncratic Risk, Market Risk and Correlation Dynamics in the US REIT Market

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Abstract

This study examines total, market and idiosyncratic risk and correlation dynamics using weekly return data on two US REIT firm samples from 1988-2008. We find that both market and idiosyncratic variance are time-varying and that idiosyncratic variance represents a dominant component of a REIT firm's total variance. While average market and idiosyncratic variance remain relatively stable over the last two decades, average correlations among individual REITs have trended upward over the same period. There is bi-lateral Granger causality between market and idiosyncratic variance and that idiosyncratic variance is influenced by shocks in market variance. Finally, we document a positive and significant relation between average idiosyncratic risks (variance and standard deviation) and expected market returns over the last 20 years. Our results have important asset pricing implications for under-diversified investors.

1. Introduction

This study investigates the dynamics of idiosyncratic risk, market risk and return correlations in the US real estate investment trust (REIT) market with two samples of REIT firms over the last 20 years. Although standard asset pricing theories such as CAPM and APT assert that idiosyncratic risk (i.e. firm level risk)[1] should not be priced in the expected asset returns, recent surge of interest in idiosyncratic risk of common stocks has generated considerable evidence as to the role of the idiosyncratic risk in common stock pricing. The main arguments supporting this interest is most investors are under-diversified either due to wealth constraints, transaction costs or specific investment objectives; as such idiosyncratic risk may matter to these less well-diversified investors who wish to be compensated with additional risk premium. It follows that these investors need to consider idiosyncratic risk (together with market risk) when estimating required return and cost of capital on the assets or portfolios. Recognizing that both systematic (market) and idiosyncratic volatility are relevant in stock asset pricing, Campbell et al. (2001), henceforth CLMX (2001), analyze long-term trends in both firm-level and market volatility in the US stock markets from 1962 to 1997 and show that a decline in overall market correlation was accompanied by a parallel increase in average firm-level volatility.

[1] Idiosyncratic risk is defined as the risk that is unique to a specific firm, so it is called firm-specific risk. By definition, it is independent of the common movement of the market.

Since the US REIT market is a very significant component of the global securitized real estate market, it is therefore important to understand clearly the dynamics of a typical REIT firm's total variance in two different volatility components; i.e. market volatility and idiosyncratic volatility as well as their relative influences on average market correlations and expected market returns. Another point to note is that on average, REITs resemble small capitalization stocks; their owners are individuals or small institutional investors who do not hold a diversified portfolio (Pagliari et al, 2003). As such, these investors would value idiosyncratic risk. Given these two features, this study is particularly meaningful since there is little published empirical research on the decomposition of long term REIT return volatility and dynamics at the firm level. In this paper, we follow CLMX (2001)'s unconditional approach to study the time-series behavior and interactions among the total variance, market variance, idiosyncratic variance, average correlations and expected returns; and further, to assess the empirical relation between idiosyncratic risk, market risk and expected return.. Specifically, our empirical strategy has two components: (a) understanding the evolution of REITs' total, market and idiosyncratic variance and correlations at the firm level as well as exploring the trends and short term interactions among the various series. These analyses will indicate whether the US REIT stocks have become more volatile (or otherwise) over the last two decades; and (b) testing the time series relation between expected market returns and market and idiosyncratic risk measures of REIT returns, with the results reveal whether there is a positive risk premium (or otherwise) associated with the market and idiosyncratic volatiluity. We employ two different REIT samples, one for 1998-2008 (10 years) and the other for 1988 -2008 (20 years) to provide a full analysis of the changing dynamics of the REITs' volatility and correlation over the last 10 and 20 years. In this regard, we contribute to the REIT firm-level literature.

We find that US REIT firms' average market and idiosyncratic variance remain relatively stable over the last two decades. A positive and significant relation between average idiosyncratic volatility (standard deviation) and expected market returns exists over the last 20 years; however our results show that market risk does not forecast average market returns over the same period. Our findings have relevance for the diversification properties of passive and active international investment strategies that includes the US REIT stocks. Further, REIT corporate management needs to understand and manage better firm-level volatility as it contributes to over 80% of total firm variance over the last two decades.

Our paper is structured as follows. Section 2 provides a brief literature review. In Section 3, we briefly explain the CLMX (2001)'s unconditional approach to produce the total variance, market variance, idiosyncratic variance and return correlations and the respective equally-weighted series. We perform a range of statistical tests to discern more formally the trends and shock dynamics of the series with Vogelsang (1998)'s trend determination, random walk test, Granger causality test as well as variance decomposition methodology, and we explain the regression approach with two stock market crisis dummy indicators to detect empirical relations between market and idiosyncratic series and average market returns. Our data set, variable construction and summary statistics are provided in Section 4. Section 5 reports and interpret the various test results to develop the main findings. Finally, Section 6 concludes the study

2. Literature review

Our literature review reveals that while there is extensive stock market literature documenting the time-series property of idiosyncratic risk and relevant asset pricing implications, less formal attention is given to the studies of securitized real estate investments such as REITs and real estate stocks where high frequency data are readily available for academics and investors. In what follows, we review several key stock market studies as well as some research papers that have investigated REITs' return volatility from different perspectives.

2.1 Stock market studies

Campbell, Lettau, Malkiel, and Xu (hereafter, CLMX) (2001) use a disaggregated approach to study the volatility of the US common stocks at the market, industry and firm levels from 1962 to 1997. They report that idiosyncratic volatility exhibits a significant upward trend, more than doubling whereas market and industry level volatilities are relatively stable over the period. Market volatility tends to lead the other volatility series. In addition, all three volatility series increase substantially during economic downturns and recessions. CLMX (2001) also report that firm level volatility predicts both market and industry level volatility in the USA. Moreover, they find that correlations among individual stocks have declined and more stocks are needed to achieve a certain level of diversification. From these findings, CLMX (2001) conclude that although the US stock market as a whole has not become more volatile, the volatility at the firm level has increased significantly over a period of 35 years. Following CLMX (2001)'s unconditional methodology, a European study by Kearney and Potì (2008) observe that average firm-level variance has trended upwards in the euro-zone area over the period 1974-2004, with the market variance also trended upwards but less than the rise in the firm-level variance. In addition, the conditional correlations tend to spike up after negative return innovations, suggesting that diversification strategies might perform poorly during prolonged bear markets. Irvine and Pontiff (2005) reported that idiosyncratic return volatility has increased 6% per year over the past forty years. They claimed that the results were mirrored by an increase in the idiosyncratic volatility of fundamental cash flows and were attributable to more intense economy-wide competition.

The relation between idiosyncratic risk and return has been found insignificant, positive and even negative in many studies. Financial theory indicates that a positive risk premium is required to compensate investors for bearing idiosyncratic risk. Early empirical results such as Lintner (1965), Merton (1987) and Lehmann (1990) reveal a positive relationship between idiosyncratic risk and expected return when investors do not diversify their portfolio. Malkiel and Xu (1999) report a positive relationship between idiosyncratic risk and expected return. Goyal and Santa-Clara (2003) find that aggregate measures of idiosyncratic volatility predict one-month-ahead excess market returns from 1962 to 1999. In contrast, market volatility has no forecasting power for the market return. Jiang and Lee (2006) claim that because idiosyncratic risk tends to be persistent over time, regressing excess returns on one-lagged volatility gives only a limited result of the dynamic effect of idiosyncratic risk. They correct for the serial correlation in idiosyncratic volatility and find a significant positive relation between returns and idiosyncratic risk. Lastly, Fu (2008) uses the generalized autoregressive conditional heteroskedasticity (GARCH) model to estimate idiosyncratic volatility from monthly stock returns. He finds a strong positive relationship between conditional idiosyncratic risk and expected returns. On the contrary, Guo and Savickas (2003) find that the equal-weighted average stock volatility forecasts stock returns because of its co-movements with stock market volatility. However, the relationship is a negative one between value-weighted average stock volatility and future stock returns. Bali et al. (2005) find no evidence of a positive relation between the value-weighted portfolio returns and value-weighted average stock volatility. Ang et al (2006a) find a negative and significant relation between idiosyncratic volatility and cross-sectional stock returns from 1963 to 2000. Finally, a recent study of Brockman and Yan (2008) report an insignificant relation between average idiosyncratic volatility and one-month-ahead excess market returns and a highly significant inverse relation between idiosyncratic volatility and cross-sectional stock returns.

2.2 REIT studies

As noted above, less formal attention has been given to the US REIT market regarding the time series behavior of idiosyncratic and market variance and their relations with expected market returns. Liang et al. (1995) investigate the variability in the risk components of REITs over the period 1973-1989. They find that both market beta and interest-rate beta of the REIT portfolios are time-varying. Winniford (2003) use a periodic, PGARCH model to analyze the key factors affect the seasonal volatility of equity REIT returns and find that REITs are correlated with stock and real estate markets; both of which also exhibit seasonal fluctuations. Clayton and MacKinnon (2000) break down the proportion of REIT volatility due to large-cap stocks, small-cap stocks, bonds and unsecuritized real estate. They report a substantial increase over time in idiosyncratic volatility in the REIT index unexplained by any of the above factors. They explain that the increase in idiosyncratic risk is consistent with the increased role of institutional investors and the greater transparency of information about REITs. Using a single-factor model, Chiang et al. (2005) REITs find weak evidence of a down ward trend in equity REIT betas over 1972-2002. There is a sharp decline in market beta occurs in 2002 under the Fama-French (1996)'s three-factor model. Chaudhry et al (2004) report efficiency, liquidity and earnings variability are important determinants of idiosyncratic risk, whereas size and capital do not have any significant effects on idiosyncratic risk.

Regarding the relation between risk and return of REITs, Ooi et al. (2009) report that firm-specific risk matters in REIT pricing. Their empirical results show that if the idiosyncratic risk is controlled in the asset-pricing model, the significance of the size, book-to-market equity ratio factors will diminish whereas the explanation power of the momentum effect remains significant in the existence of idiosyncratic volatility. Najand et al. (2006) use GARCH and GARCH-M specifications to investigate the time varying risk premium for equity REITs. Their study shows that the market returns and the first order autocorrelation are relevant in explaining the excess returns of equity REITs. However, the GARCH-M terms are not significant in forecasting the expected returns.

3. Methodologies

This study uses several methodologies. First, the variance decomposition methodology of CLMX (2001) is used to construct three unconditional variance and one average correlation series Second, the time-series property of the four series are described and tested for random walk hypothesis. Third, we estimate their long-run trend using a regression model with two stock market crisis dummy indicators as well as Vogeslang (1998)'s robust trend statistic (t-PS). Fourth, a bi-variate vector auto-regression model models the short run dynamics of market and idiosyncratic variance, which includes the Granger causality test and variance decomposition. Lastly, regression analyses are conducted to investigate the relationship between market and idiosyncratic volatility and expected market returns.

3.1 Unconditional estimates: market, firm-level, total variances and average correlations

First, the simplified market model is written as follow:

$$r_{i,t} = \beta_i \; r_{m,t} + \varepsilon_{i,t} = \quad r_{m,t} + \eta_{i,t} \quad (1)$$

Where, $r_{i,t}$ is the excess return on asset *i* at time *t*, $r_{m,t}$ is the excess return on the market portfolio, β_i is the asset's *beta* coefficient, $\varepsilon_{i,t}$ is the usual CAPM idiosyncratic residual and $\eta_{i,t}$ is the market-adjusted excess return on asset *i*.

Letting $w_{i,t}$ be the weight of asset *i* in the market portfolio. In an equally-weighted portfolio, the weights of a REIT equal to 1/ *n*. In a value-weighted portfolio, the weights are the ratios of the market value of each REIT to the sum of market value across all REITs in the sample. The weighted average of the variance of returns on the *n* stocks in the market portfolio is calculated.

$$\sum_{i=1}^{n} \mathrm{w}_{\mathrm{i,t}} Var(r_{i,t}) = \quad Var(r_{m,t}) + \sum_{i=1}^{n} \mathrm{w}_{\mathrm{i,t}} Var(\eta_{i,t}) \quad + \sum_{i=1}^{n} \mathrm{w}_{\mathrm{i,t}} \; 2Cov(r_{m,t}, \eta_{i,t}) \quad (2)$$

Taking into consideration that $r_{m,t}$ and $\varepsilon_{i,t}$ are orthogonal and the weighed average of the β_i coefficients is equal to 1, the study substitute for $\eta_{i,t}$ from (1), hence the last term on the right of (2) equals to zero. The CLMX (2001) variance decomposition is obtained:

$$VAR_t = \sum_{i=1}^{n} \mathrm{w}_{\mathrm{i,t}}\, Var(r_{i,t}) \quad = Var(r_{m,t}) + \sum_{i=1}^{n} \mathrm{w}_{\mathrm{i,t}}\, Var(\eta_{i,t}) + \sum_{i=1}^{n} \mathrm{w}_{\mathrm{i,t}}\; 2(\beta_i - 1)\, Var(r_{m,t})$$

$$= Var(r_{m,t}) + \sum_{i=1}^{n} \mathrm{w}_{\mathrm{i,t}}\, Var(\eta_{i,t})$$

$$= MKT_t + FIRM_t \qquad (3)$$

Similar to the CAPM decomposition of average total risk into market risk and average idiosyncratic risk, the average excess return variance across all assets in the market portfolio (VAR_t) comprises the variance of the excess return on the market portfolio (MKT_t) and the average firm-level variance ($FIRM_t$). Notice here equation (3) bypasses the estimation of time-varying betas for each firm.

By rewriting Equation (3) in matrix form and further assuming that the market portfolio is well diversified, Kearney and Poti (2008) shows that the average correlation can be expressed as the ratio of the market variance to the square of the average firm volatility, i.e.

$$Corr_t = MKT_t \blacksquare FIRM_t$$

3.2 Long run trends

We examine the time trends in total variance (VAR), market variance (MKT), firm variance (FIRM) and average correlation (CORR) for both samples. First, we test for a significant deterministic time trend by fitting the following two regression models:

Sample A (1998-2008)

$$FIRM_t = \lambda_0 + \lambda_1 Trend_t + \lambda_2 FIRM_{t\text{-}1} + \lambda_3 S0003Dummy_t + \lambda_4 S0708Dummy_t + \varepsilon_t$$

Sample B (1988-2008)

$$FIRM_t = \lambda_0 + \lambda_1 Trend_t + \lambda_2 FIRM_{t\text{-}1} + \lambda_3 S0003Dummy_t + \lambda_4 S0708Dummy_t + \lambda_5 REITNEWDummy_t + \varepsilon_t$$

Where: REITNEW dummy is an indicator variable for the new REIT era which is equal to 1 for all weeks during 1993-2008. S0708 dummy is an indicator variable for the global financial crisis (which is still undergoing) which is equal to 1 for all weeks during October 12, 2007 –September 26, 2008 (inclusive). S0003 dummy is an indicator variable for the US stock market downturn which is equal to 1 for all weeks during September 1, 2000 – March 14, 2003 (Source: US stock market index based on S&P data – Exhibit 1)

The above two regression specifications are designed to account for possible persistence in VAR/MKT/FIRM/CORR by including lagged variable using Newey and West (1987) standard errors and covariance. However, Vogeslang (1998) points out that when regression errors are persistent, the Newey and West (1987) standard errors might still reject the null hypothesis of no trend too often. To address this problem, we use Vogeslang's (1988) simple linear time trend test. The benchmark model is:

$$Y_t = \alpha + \beta * TREND + \varepsilon_t$$

where Y_t is the variable of interest, and $TREND$ is a linear time trend. We use PS1 test in Vogeslang to test β =0. The test statistic is robust to I(0) and I(1) error term.

3.3 Short-run dynamics

We specify a bi-variate vector autoregression (VAR) model of the relation between the market variance, *MKT*, and idiosyncratic firm variance, *FIRM*

Specifically, the VAR (*p*) model consists of two equations (*p* denoting the lag length):

$$MKT_t = \beta_{10} + \beta_{11} MKT_{t-1} + ... + \beta_{1p} MKT_{t-p} + \gamma_{11} FIRM_{t-1} + ... + \gamma_{1p} FIRM_{t-p} + u_{1t}$$

$$FIRM_t = \beta_{20} + \beta_{21} MKT_{t-1} + ... + \beta_{2p} MKT_{t-p} + \gamma_{21} FIRM_{t-1} + ... + \gamma_{2p} FIRM_{t-p} + u_{2t}$$

Where the β 's and the γ 's are unknown coefficients and u_{1t} , u_{2t} are error terms. The appropriate lag length is 1 using the Akaike Information Criterion (AIC) and the Swartz Bayesian Criterion (SBC). We perform Granger causality test on the MKT and FIRM variables to determine whether lags of one variable Granger-cause the other. Variance decomposition test is used to assess the relative importance of one risk measure in contributing to the fluctuations of the other risk series.

3.4 Relations between volatility and market returns

We examine whether under-diversified investors are compensated for bearing idiosyncratic risk. Theory suggests that the risk and return tradeoff should be contemporaneous, and as such investors should earn returns for bearing the risk in the same period. Therefore if idiosyncratic volatility is priced, investors should expect a positive empirical relation between expected return and expected idiosyncratic volatility. Following finance literature, in this study we investigate if there is a significant relationship between market/idiosyncratic volatility and average realized returns (as a proxy for expected return). We use two variance measures (MKT and FIRM) and two volatility (defined as the standard deviation of the variance series) measures (idiosyncratic volatility: IVOL and market volatility: IMKT) to specify the following six regression models for the two samples:

$$RETURN_t = \beta_0 + \beta_1 Lag(FIRM)_{t-1} + \beta_2 REITNEW_t + \beta_3 S0003_t + \beta_4 S0708_t + \varepsilon_t$$

$$RETURN_t = \beta_0 + \beta_1 Lag(MKT)_{t-1} + \beta_2 REITNEW_t + \beta_3 S0003_t + \beta_4 S0708_t + \varepsilon_t$$

$$RETURN_t = \beta_0 + \beta_1 Lag(FIRM)_{t-1} + \beta_2 Lag(MKT)_{t-1} + \beta_3 REITNEW_t + \beta_4 S0003_t + \beta_5 S0708_t + \varepsilon_t$$

$$RETURN_t = \beta_0 + \beta_1 Lag(IVOL)_{t-1} + \beta_2 REITNEW_t + \beta_3 S0003_t + \beta_4 S0708_t + \varepsilon_t$$

$$RETURN_t = \beta_0 + \beta_1 Lag(IMKT)_{t-1} + \beta_2 REITNEW_t + \beta_3 S0003_t + \beta_4 S0708_t + \varepsilon_t$$

$$RETURN_t = \beta_0 + \beta_1 Lag(IVOL)_{t-1} + \beta_2 Lag(IMKT)_{t-1} + \beta_3 REITNEW_t + \beta_4 S0003_t + \beta_5 S0708_t + \varepsilon_t$$

Where: REITNEW dummy is an indicator variable for the new REIT era which is equal to 1 for all weeks during 1993-2008 (not applicable for sample A). S0708 dummy is an indicator variable for the global financial crisis (which is still undergoing) which is equal to 1 for all weeks during October 12, 2007 –September 26, 2008 (inclusive). S0003 dummy is an indicator variable for the US stock market downturn which is equal to 1 for all weeks during September 1, 2000 – March 14, 2003. All variance and volatility series are first linearly detrended.

4. Sample, return characteristics and variable proxies

This study uses weekly return data retrieved from Datastream. As of end September 2008, there are 336 USA REITs available from the Datastream. We derive two samples of the US REITs from this population. Sample A consists of 122 US REITs with continuous returns from 2 January 1998 to 26 September 2008 (10 years). Sample B comprises 40 US REITs and covers a period of 20 years starting from 1 January 1988 to 26 September 2008. Our choice of the 10- and 20- year study period allows for the determination of time trends for the relevant time series (see methodology below) while also avoid the 1987 October stock market crash that may bias the findings. Based on Exhibit 2 which shows the explosive growth in public REIT market capitalization in the 1990's, we classify the full study period into: vintage REIT era: 1988-1992 and REIT new era: 1993-2008 (Downs and Patterson, 2005).

Exhibits 3 and 4 list the names of REITs, their industry classification, and their market value for both samples. The individual REITS are grouped into 11 industries, namely diversified REIT, hotel and lodging REIT, industrial and office REIT, mortgage REIT, residential REIT, retail REIT, specialty REIT, self storage REIT, finance REIT, hybrid REIT and health care REIT. As the numbers indicate, the industry with the most REITs is Retail with 27 Retail REITs in sample A and 10 Retail REITs in Sample B. The industry with the fewest REITs is Self Storage with 3 Self Storage REIT in Sample A and 1 Self Storage REIT in sample B. The market capitalization of the REITs ranges from USD 0.1 million to 22,436 million in sample A and from 0.37 million to 16,529 million in sample B, respectively.

(Exhibits 3 and 4 here)

Exhibit 5 provides the usual set of summary statistics for the average weekly REIT returns for Samples A and B. As expected, the weekly returns exhibit significant departure from the normal distribution in both samples.

(Exhibit 5 here)

Next, we define market variance (MKT_t) as the squared deviation of weekly market returns ($R_{m,t}$) from their sample mean, ($\overline{R_m}$). $R_{i,t}$ is the return on REIT *i* at time *t*, i.e..

$$MKT_t = (R_{m,t} - \overline{R_m})^2 \qquad \text{with } R_{m,t} = \sum_{i=1}^{n} \mathrm{w}_{i,t} R_{i,t}$$

To construct the average total variance series, VAR, the weekly variance for each individual REIT in the two samples is computed, $Var(R_{i,t})$, as the sum of the squared deviation of weekly return from the sample mean, $\overline{R_i}$.

$$Var(R_{i,t}) = (R_{i,t} - \overline{R_i})^2$$

The average total variance (VAR_t) is then defined as the average across the variances, $Var(R_{i,t})$, of all REITs in the sample.

$$VAR_t = \sum_{i=1}^{n} \mathrm{w}_{\mathrm{i,t}} Var(R_{i,t})$$

The average firm-level variance is then: $FIRM_t = VAR_t - MKT_t$

The stock weights are equal to 1/n (n=122, sample A and 40, sample B)

Finally, we construct weekly correlation measures for each pair of REITs *i* and *j* as:

$$r_{i,j,t} = \sum_{t=1}^{T} (R_{i,t} - \overline{R_i})(R_{j,t} - \overline{Rj})$$

and the average correlation is the average across all the correlations:

$$r_t = \sum_{i=1}^{n}\sum_{j=1}^{n} w_{i,t} w_{j,t} r_{i,j,t}$$

In the case of equally weighted portfolio, the average correlation series is $r_t = \dfrac{MKT_t}{VAR_t}$

5. Empirical Results

We divide our empirical results into four sections. In the first section, we provide our evidence on the time-series property of VAR, MKT, FIRM and CORR. In the second section, we provide our formal test evidence on the time trend in the four measures. Then we report results regarding the short-term interaction between MKT and FIRM in the third section. Finally, we investigate the predictive ability of average idiosyncratic and market volatilities for market returns.

5.1 Time-series property of VAR, MKT, FIRM and CORR

The decomposition of the equally weighted average total stock variance (VAR) into its market (MKT) and idiosyncratic (FIRM) components is first plotted in Exhibit 6 (Sample A) and Exhibit 7 (Sample B), and the ratio of FIRM to VAR is then plotted in the same Exhibits. The third graphs in each Exhibit plot the equally-weighted average REIT correlations. Inspection of the graphs reveals that all variance series are time-varying with VAR and FIRM co-move most of the times. Idiosyncratic variance is the largest component of average total variance (83.1% and 90.1% for Samples A and B respectively), and average REIT correlation (which is also time-varying) is usually below 0.4 suggesting that the potential benefit to diversification strategies is substantial. It is noticeable that the average correlation mirrors the ratio of the average firm-level variance to the average total variance in both Exhibits, implying that average correlation is the mechanism that divides average total risk into average idiosyncratic risk and market variance (covariance risk)

(Exhibits 6 and 7 here)

We report descriptive statistics for average FIRM, MKT, VAR and CORR in Exhibit 8. Panel A includes the mean, standard deviation, coefficient of variation and serial correlations (up to 12 lags) for our variables for both samples. The weekly time series VAR, FIRM and MKT is on average, respectively, 0.189%, 0.157% and 0.032% for Sample A and 0.191%, 0.172% and 0.020% for Sample B. The mean coefficient of variation for FIRM is between 1.006 and 1.363 indicating that the standard deviation of FIRM for a typical REIT is over at least 100% of its time series mean. This suggests individual REIT idiosyncratic risks vary substantially over time. The last columns report the auto-correlations of the variables. The mean autocorrelations of the three variance variables are respectively between 0.215-0.349 for Sample A and between 0.224-0.373 for Sample B at the first lag and decay slowly. In contrast, the mean autocorrelations of the average correlations are lower, with 0.128 and 0.165 for Samples A and B respectively.

In Panel B of Exhibit 8, we compare two sets of variance results: one for the vintage REIT era (1988-1992), and the other for the new REIT era (1993-2008), as the year 1993 is widely regarded as the point at which the REIT market experiences a structural change (Glascock et al., 2000). As the numbers indicate, the new REIT era was associated with higher market risk and lower idiosyncratic risk. Compared with the REIT vintage era, the average correlation also experiences an increase in the new REIT era. Parametric ANOVA test and non-parametric Wilcoxin test reveal that the differences in MKT, FIRM and CORR series across the two eras are statistically significant at the one percent level.

We report correlations among the three variance series in Panel C of Exhibit 8. For both samples, the highest correlation (0.970-0.980) is between FIRM and VAR, consistent with the earlier visual observation that the two variance series always co-move together. The lowest correlation is between market and idiosyncratic variance (0.317-0.442)

(Exhibit 8 here)

The autocorrelation evidence in Exhibit 8 suggest that the random walk hypothesis is likely not appropriate for the three variance series.[2] To test this possibility, Exhibit 9 presents statistics of the estimations from the time-series regressions in which the changes in the average MKT (and FIRM) estimates are regressed on the level of average MKT (FIRM) estimates in the previous week. Similar examinations on Ln (MKT/FIRM) are also conducted. The t-statistics are compared with the Augmented Dickey-Fuller (ADF) critical values to examine whether the null hypothesis of a random walk is rejected. The two time series regression models are:

Model 1:

$$MKT_{t+1} - MKT_t = \varphi_0 + \varphi_1 MKT_t + \varepsilon_t ; FIRM_{t+1} - FIRM_t = \varphi_0 + \varphi_1 FIRM_t + \varepsilon_t ; t = 1,2....T$$

Model 2:

$$LnMKT_{t+1} - \ln MKT_t = \varphi_0 + \varphi_1 LnMKT_t + \varepsilon_t ; LnFIRM_{t+1} - \ln FIRM_t = \varphi_0 + \varphi_1 LnFIRM_t + \varepsilon_t ; t = 1,2....T$$

Similar to the unit root test, the coefficient φ_1 should be indistinguishable from zero if the time series of MKT and FIRM follow a random walk. For each time series, the coefficient φ_1 is estimated and its t-statistic is compared with the ADF 5% critical value for the unit root tests. According to the ADF comparison, the null hypothesis of a random walk for the three variance series is rejected. Examinations on LN series yield very similar results. The results imply that it is not appropriate to characterize a typical REIT's total, market and idiosyncratic variance process as a random walk. Accordingly, using a one-lagged value of these volatilities in examining the dynamic effect of these volatilities on returns can be misleading.

(Exhibit 9 here)

5.2 Long-run trends

[2] The first-order autocorrelation for a random walk process should be one, and the first differences of a random walk are a white noise and therefore the autocorrelation should be zero at all lags.

The estimates of a deterministic time trend for the variance and correlation series are reported in Exhibit 10. Since the four time series measures are quite persistent, we use Newey and West's (1987) heteroskedasticity and autocorrelation consistent standard errors and we report our time trend findings in Panel A (Sample A) and Panel B (Sample B) of the Exhibit.

(Exhibit 10 here)

The results in Panel A reveal a negative and significant time trend for the FIRM variance between 1998 and 2008. The weekly trend coefficient is -1.66×10^{-6}, which implies that over the sample period (561 weeks), average idiosyncratic variance experienced a total decline of about 0.093 per cent in magnitude. In consistent with this lower idiosyncratic variance estimate, the weekly trend coefficient of CORR is positive and statistically significant with an estimate of 3.23×10^{-4}, implying that an increase of approximately 18.1 per cent in average correlations among the REIT stocks over 1998-2008. The coefficients on the current financial crisis dummy (S0708) are positive and significant across all three variance series; and significantly negative in the CORR regression. The coefficients on the three lagged variance measures are positive and significant, consistent with the evidence in Exhibit 8 that the average VAR, MKT and FIRM measures are highly persistent. In contrast, the results in Panel B (1988-2008) reveal a significantly positive time trend for the MKT variance, with a weekly trend coefficient of 2.69×10^{-7}, which is equivalent to a negligible increase of about 0.029% over the last two decades (1082 weeks). Parallel to this increase in market variance is an increase of about 20.23% in the average correlations (CORR) over the same period – the time trend coefficient for CORR is 1.87×10^{-4}, which is statistically significant at the 1% level.

In Panel C, we report the trend coefficient, the t-PS statistic and the 5% critical value derived in Vogeslang (1998) for a two side-test. The results show significant evidence of an upward trend in average correlations (CORR) in Sample A (β = 0.0003) and Sample B (β =0.0001). However, no significant and robust trends are detected for FIRM (Sample A) (β = 0.0000) and MKT (Sample B) (β = 0.0000) when we use the Vogeslang size-robust trend test.

In summary, we document a fairly stable trend in both samples with regard to the evolution of average total variance, market variance and idiosyncratic variance, implying that the US REIT stocks have not become more volatile (at the systematic and firm risk level) during the last one and two decades. On the other hand, the documented positive trends in average correlations (CORR) among the REIT stocks over the last 10 and 20 years could be due to the impact of globalization and financial market integration in global REIT investing

5.3 Short run dynamics

Exhibit 11 reports Granger Causality Test results between MKT and FIRM.The appropriate lag length is 1 using the Akaike Information Criterion (AIC) and the Swartz Bayesian Criterion (SBC). As the numbers indicate, there is statistically significant evidence of bilateral causality between MKT and FIRM in both samples - MKT Granger-causes FIRM and FIRM Granger-causes MKT.

(Exhibit 11 here)

The corresponding variance decomposition of the variance of MKT and FIRM for 1, 2, 3, 4, 8 and 12-week are reported in Exhibit 12. As the numbers indicate, the majority of market variance, over 97% one-period ahead, is explained by the shocks originated from itself; whereas between 10% and 20% of idiosyncratic variance is explained by variation in MKT after 12 weeks. These results imply that the market variance is largely exogenous as its own innovations account for most of its error variance. Comparatively, the idiosyncratic variance is endogenous. Comparatively, firm level variance appears to play a weaker role in driving the systematic level variance in the US REIT market.

(Exhibit 12 here)

5.4 Relation between market returns, market volatility and idiosyncratic volatility

The results are reported in Exhibit 13 (Sample A) and Exhibit 14 (Sample B). Panel A of the Exhibits presents the simple contemporaneous correlations between the realized average return (RET), market variance (MKT) and firm variance (FIRM) and between the realized average return (RET), market volatility (IVOL – defined as the square root of MKT) and idiosyncratic volatility (IVOL – defined as the square root of FIRM). As the numbers indicate, with minor exceptions, all four measures of risk have a negative and insignificant influence each on contemporaneous market returns.

(Exhibits 13 and 14 here)

Panel B reports the coefficient estimates and t–statistics based on Newey and West standard errors and covariance (in parenthesis) from the six regression models (see Section 3.4) where the dependent variables are the expected market return. In sample A, none of the four risk measures are statistically significant implying no empirical relation between market risk, idiosyncratic risk and future returns. In sample B, a positive relation each is picked up between two current idiosyncratic risk measures and future market returns. This positive relation is however statistically significant at the 10 percent level only. In contrast, we detect a statistically insignificant and negative relation between each of the two market risk variables and expected return. Finally, the positive influence of the two idiosyncratic risk measures on expected return remain statistically significant when combined with market risk measures.

In summary, subject to measurement errors in the expected volatility variables (i.e. one-week volatility value is not a good proxy for the expected value),[3] we are able to detect a positive relation between idiosyncratic volatility and expected returns, implying that the risk premium of REITs is positively related to idiosyncratic risks over the last 20 years. Hence despite the structural changes experienced in the US REIT market especially in the 1990's, REIT investors, similar to stock market investors, demand compensation for not being able to diversify risk. The implication to practitioners and investors is that REIT idiosyncratic risk does matter.

6. Conclusion

Our contribution in this paper has been to characterize the time-series property of the US REIT firm level risk and correlation measures over the last 10 and 20 years. Using two weekly samples and different methodologies, we examine REIT firms' total variance (VAR), market variance (MKT), idiosyncratic variance (FIRM) and their average correlations (CORR). We focus on the respective long-term deterministic trends, their short-term dynamics as well as whether there is a significant relation between the risk measures and expected market returns.

Our main results are as follows. Both market and idiosyncratic variance are time-varying and that the random walk variance process is rejected. Idiosyncratic variance makes up over 80 percent of a typical REIT firm's total variance. We find no evidence to suggest that the US REIT firms have become more

[3] This is because, as shown earlier, idiosyncratic and market variance are persistent and serially correlated, as such a one-period-ahead forecast regression approach may give a partial understanding of the dynamic time-series relations between stock returns and idiosyncratic risk (market risk). An alternative is to use serially uncorrelated (i.e. orthogonalized) innovations (unexpected changes) in volatility as regressors in the regression and then use the moving average approach to examine the significance of each coefficient (Jiang and Lee, 2006).

volatile at the market and individual firm levels over the last 10 and 20 years. Both their market and idiosyncratic variance remain relatively stable with a positive increase of average firm correlation of about 20% over the last two decades. Future research can explore further the implications of level and dynamics of market variance, firm variance and average firm correlation for the implementation of naïve equally-weighted diversification strategy relative to more complicated mean-variance optimization rules. Regarding the short-run dynamics, there is bi-lateral Granger causality between market and idiosyncratic variance and that the idiosyncratic variance can be influenced by shocks in the market variance. Finally, in consistent with some stock market literature (Goyal and Santa Clara, 2003) , we find that average idiosyncratic risks (variance and volatility) are able to positively predict expected market returns over the last 20 years. This has important asset pricing implications for under-diversified investors.

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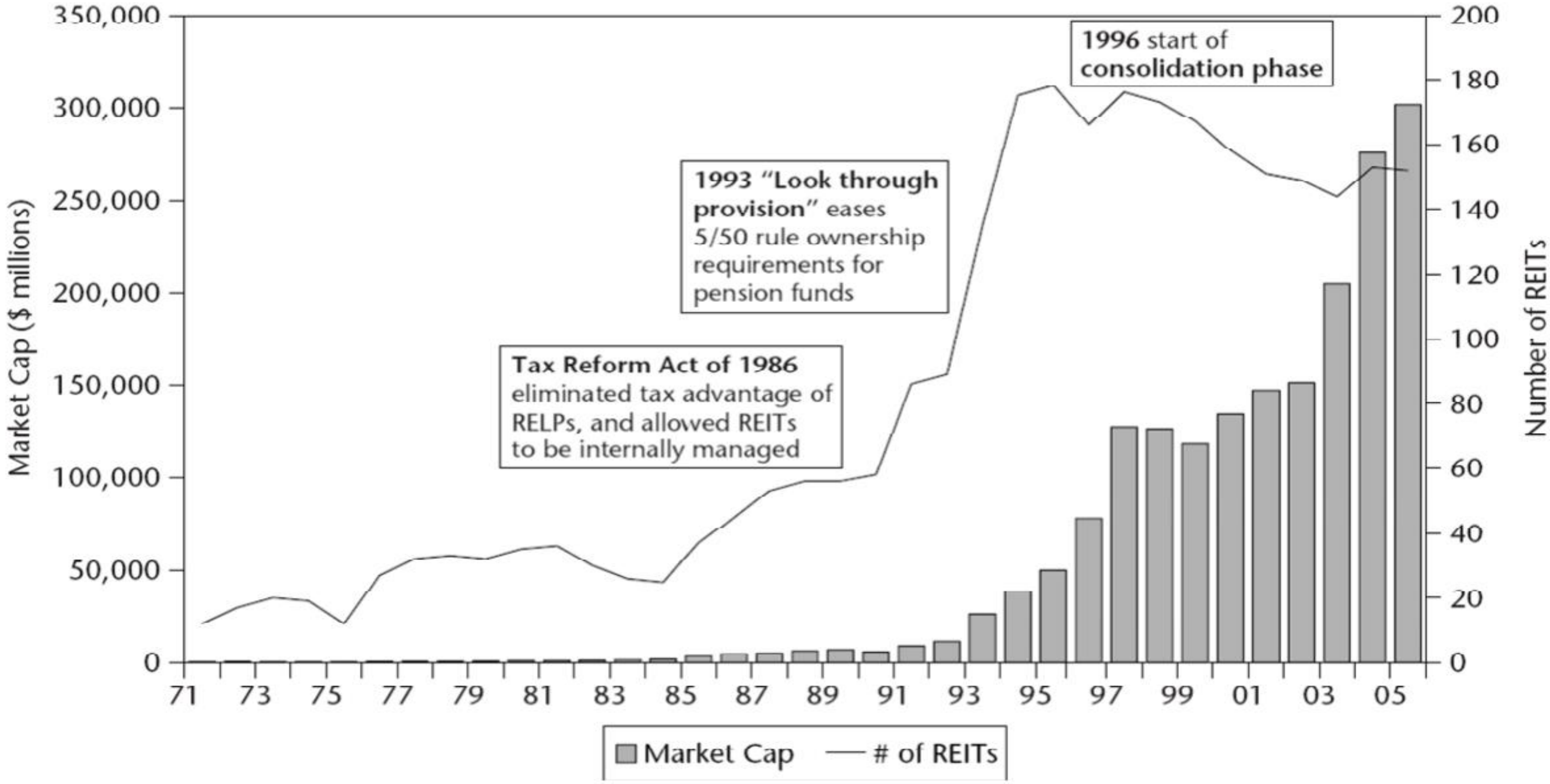
Exhibit 1

Source: S & P Broad Market Index

Exhibit 2 US REIT Market



Source: NAREIT

Exhibit 3 List of the US REITs included in sample A (1998 – 2008) -122 REITs

Name of REITs	Sector	MV	Name of REITs	Sector	MV	Name of REITs	Sector	MV
REALTY INCOME	RITRT	2730.12	ESSEX PR.TST.PF.SR.F	RITRS	25.92	PMC COML.TST.	RITMG	86.8
GETTY REALTY	RITRT	519.84	MAXUS REALTY TST.	RITRS	13.25	RAIT FINANCIAL TRUST	RITMG	402.65
AGREE REALTY	RITRT	215.14	POST PROPERTIES	RITRS	1278.77	THORNBURG MGE.	RITMG	108.38
ALEXANDER'S	RITRT	1892.47	UDR	RITRS	3584.87	WEBSTER PF.CAP.CORP.PF.	RITMG	9.24
NATIONAL RETAIL PROPS.	RITRT	1765.81	UMH PROPERTIES	RITRS	81.57	ECONOMIC INVESTMENT TST.	RITFN	412.31
CBL & ASSOCIATES PROPS.	RITRT	1408.89	SUN COMMUNITIES	RITRS	367.9	ECONOMIC IT.PF.A 5%	RITFN	0.37
GLIMCHER REAL.TST.	RITRT	391.93	AMERICAN LD.LEASE	RITRS	147.01	CDN.RLST.INV.TST.UNT.	RITDV	1657.14
PENN.REIT.	RITRT	808.77	EQUITY LIFESTYLE PROPS.	RITRS	1328.88	ENTERTAINMENT PROPS TST BENINT	RITDV	1677.21
TAUBMAN CENTERS	RITRT	2644.12	SOVRAN SELFSTORAGE	RITSS	935.55	COLONIAL PROPS.TST.	RITDV	841.29
SIMON PR.GP.	RITRT	22435.57	PUBLIC STORAGE PF.SR.E 6.75%	RITSS	0.1	H&R RLST.IT./ FIN.TST.	RITDV	2091.8
GENERAL GW.PROPS.	RITRT	4564.35	PUBLIC STORAGE	RITSS	16528.8	COUSINS PROPS	RITDV	1312.15
MACERICH	RITRT	4859.19	MACK CALI REAL.	RITIO	2346.87	HMG/COURTLAND PROPS.	RITDV	5.07
DEVELOPERS DIVR.REAL.	RITRT	4017.08	BRANDYWINE REAL.TST.SHBI	RITIO	1474.47	ONE LIBERTY PROPS.	RITDV	181.84
FEDERAL REALTY INV.TST.	RITRT	5021.15	CORPORATE OFFICE PROPS.TST	RITIO	1948.31	VORNADO REALITY TST.PF. CONVSV'A'	RITDV	738.97
KIMCO REALTY	RITRT	9750.2	SL GREEN REALTY	RITIO	4080.97	VORNADO REALTY TST.	RITDV	14574.8
ACADIA REAL.TST.SHRE.	RITRT	811.69	HIGHWDS.PROPS.PF.'B' 8%	RITIO	144.55	WASH.RL.EST.INV.	RITDV	1690.13
RAMCO-GERSHENSON PROPS.	RITRT	426.38	PARKWAY PROPERTIES	RITIO	602.43	WINTHROP REALTY TRUST	RITDV	305.84
RIOCAN REIT.TST.	RITRT	4275.94	KILROY REALTY	RITIO	1597.34	LEXINGTON REALTY TRUST	RITDV	971.51
REGENCY CENTERS	RITRT	4614.52	ALEXANDRIA RLST.EQTIES.	RITIO	3628.88	ISTARFINL.PF.SR.'D'	RITHB	25.64
TANGER FAC.OUTLET CNTRS.	RITRT	1397.67	HRPT PROPERTIES TRUST	RITIO	1663.89	ISTAR FINL.	RITHB	508.32
CEDAR SHOP.CENTERS	RITRT	607.26	BOSTON PROPERTIES	RITIO	11347.3	NAT. HEALTH INVRS.	RITHB	929.96
WEINGARTEN REALTY INVRS.	RITRT	2975.48	HIGHWOODS PROPS.	RITIO	2115.11	LTC PROPS.	RITHB	661.9
URSTADT BIDDLE PROPS.	RITRT	140.85	AMB PROPERTY PF.SR.O	RITIO	55.92	HEALTHCARE REAL.TST.	RITHC	1418.18
SAUL CENTERS	RITRT	861.36	EASTGROUP PROPS.	RITIO	1218.08	VENTAS	RITHC	6754.95
PRES.REALTY 'A'	RITRT	2.04	MONMOUTH REIT.	RITIO	185.67	NATIONWIDE HEALTH PROPS.	RITHC	3507.38
PRESIDENTIAL REALTY B	RITRT	14.52	PROLOGIS	RITIO	10491	HCP	RITHC	9342.23
ROBERTS REAL.INVRS.	RITRT	24.05	FIRST INDL.REALTY TST.	RITIO	1293.91	HEALTH CARE REIT	RITHC	4983.67
FIRST REIT.TST.OF NJ.	RITRS	162.47	PS BUSINESS PARKS	RITIO	1175.36	EXTENDICARE REIT.	RITHC	439.59
EQ.RESD.PR.TST.PF.CV.'E'	RITRS	195.71	DUKE REALTY	RITIO	3766.18	OMEGA HLTHCR.INVRS.	RITHC	1455.83
BOARDWALK RLST.INV.TST.	RITRS	1635.18	LIBERTY PROPERTY TST.	RITIO	3564.94	FELCOR LODGING TST.	RITHL	445.96
BRE PROPERTIES	RITRS	2590.07	CAP.TST.'A'	RITMG	296.45	FELCOR LODGING TST.PF. CV'A'	RITHL	81.67
CAMDEN PROPERTY TST.	RITRS	2525.05	CAPSTEAD MGE.	RITMG	609.56	HOSPITALITYPROPS.TST. SHRE.BENL.INT.	RITHL	1936.33
MID-AMER.APT COMMUNITIES	RITRS	1412.57	CAPSTEAD MGE.PF.A	RITMG	6.54	HOST HOTELS & RESORTS	RITHL	7246.6
ASSOCIATED ESTATES REAL.	RITRS	216.22	CAPSTEAD MGE.PF.B CV.	RITMG	210.08	SUPERTEL HOSPITALITY	RITHL	85.1
AVALONBAY COMMNS.	RITRS	7647.38	NOVASTAR FINL.	RITMG	10.61	MIDDLETON DOLL	RITSP	0.88
APARTMENT INV.& MAN.'A'	RITRS	3012.08	BRT REALTY TRUST	RITMG	82.98	PITTS.& WEST VA.	RITSP	14.18
POST PROPS.PF.'B' 7.625	RITRS	29.28	FRIEDMAN BILLINGS RAMSEY REIT.'A'	RITMG	236.38	PLUM CREEK TIMBER	RITSP	8689.82
HOME PROPS.	RITRS	1857.42	REDWOOD TST.	RITMG	807.48	POTLATCH	RITSP	1975.59
POST PROPS.PF.'A' 8.5%	RITRS	37	IMPAC MORTGAGE HDG.	RITMG	13.7	RAYONIER	RITSP	3775.57
EQUITY RESD.PROPS.TST. PFCVH 175	RITRS	12.03	ANNALY CAPITAL MAN.	RITMG	8331.36	UNVL.HLTH.REAL.INC.TST.	RITSP	457.48
EQUITY RESD.TST.PROPS. SHBI	RITRS	12329.88	DYNEX CAP.	RITMG	96.02			

Note: MV: Market Value as at 26 Sep 2008 (million); RITDV: Diversified REIT; RITFN: Finance REIT; RITHB: Hybrid REIT; RITHC: Health care REIT; RITHL: Hotel and lodging REIT; RITIO: Industrial and office REIT; RITMG: Mortgage REIT; RITRS: Residential REIT; RITRT: Retail REIT; RITSP: Specialty REIT; RITSS: Self Storage REIT. (Source:Datastream)

Exhibit 4
List of the US REITs included in Sample B (1988 -2008) – 40 REITs

Name of REITs	**Sector**	**MV**	**Name of REITs**	**Sector**	***MV***
ALEXANDER'S	RITRT	1892.47	PARKWAY PROPERTIES	RITIO	*602.43*
GETTY REALTY	RITRT	519.84	EXTENDICARE REIT.	RITHC	*439.59*
NATIONAL RETAIL PROPS.	RITRT	1765.81	HCP	RITHC	*9342.23*
URSTADT BIDDLE PROPS.	RITRT	140.85	HEALTH CARE REIT	RITHC	*4983.67*
CEDAR SHOP.CENTERS	RITRT	607.26	NATIONWIDE HEALTH PROPS.	RITHC	*3507.38*
WEINGARTEN REALTY INVRS.	RITRT	2975.48	MIDDLETON DOLL	RITSP	*0.88*
FEDERAL REALTY INV.TST.	RITRT	5021.15	PITTS.& WEST VA.	RITSP	*14.18*
PENN.REIT.	RITRT	808.77	POTLATCH	RITSP	*1975.59*
PRES.REALTY 'A'	RITRT	2.04	MAXUS REALTY TST.	RITRS	*13.25*
PRESIDENTIAL REALTY B	RITRT	14.52	BRE PROPERTIES	RITRS	*2590.07*
WINTHROP REALTY TRUST	RITDV	305.84	UDR	RITRS	*3584.87*
COUSINS PROPS	RITDV	1312.15	UMH PROPERTIES	RITRS	*81.57*
ONE LIBERTY PROPS.	RITDV	181.84	AMERICAN LD.LEASE	RITRS	*147.01*
VORNADO REALTY TST.	RITDV	14574.82	BRT REALTY TRUST	RITMG	*82.98*
WASH.RL.EST.INV.	RITDV	1690.13	CAP.TST.'A'	RITMG	*296.45*
HMG/COURTLAND PROPS.	RITDV	5.07	CAPSTEAD MGE.	RITMG	*609.56*
MONMOUTH REIT.	RITIO	185.67	ECONOMIC INVESTMENT TST.	RITFN	*412.31*
EASTGROUP PROPS.	RITIO	1218.08	ECONOMIC IT.PF.A 5%	RITFN	*0.37*
HRPT PROPERTIES TRUST	RITIO	1663.89	HOST HOTELS & RESORTS	RITHL	*7246.6*
BRANDYWINE REAL.TST.SHBI	*RITIO*	*1474.47*	*PUBLIC STORAGE*	*RITSS*	*16528.78*

Note: MV: Market Value as at 26 Sep 2008 (million); RITDV: Diversified REIT; RITFN: Finance REIT; RITHB: Hybrid REIT; RITHC: Health care REIT; RITHL: Hotel and lodging REIT; RITIO: Industrial and office REIT; RITMG: Mortgage REIT; RITRS: Residential REIT; RITRT: Retail REIT; RITSP: Specialty REIT; RITSS: Self Storage REIT.

Source: Datastream

Exhibit 5
Descriptive statistic of weekly returns

This table provides the time series statistics of mean, standard deviation, maximum, minimum, skewness, kurtosis and Jarque-Bara Statistic of the REIT stocks in the two research samples. * - indicates two-tailed significance at the 1 percent level

Sample	No of REITs	Period	Mean (%)	Standard deviation (%)	Maximum (%)	Minimum (%)	Skewness	Kurtosis	Jarque-Bara Statistic
A	122	1998-2008	0.138	1.801	6.033	-7.834	-0.627	5.429	174.55*
B	40	1988-2008	0.181	1.408	5.058	-7.451	-0.457	5.591	340.38*

Exhibit 6

Total, market and idiosyncratic variances and average correlations of US REITs (Sample A:1998-2008)

The first plot shows the decomposition of the total variance (VAR) of a US REIT into its market (MKT) and idiosyncmtic (FIRM) component. Second is the ratio of FIRM to VAR, followed by a plot of the equally-weighted average correlation amongst the 122 REITs

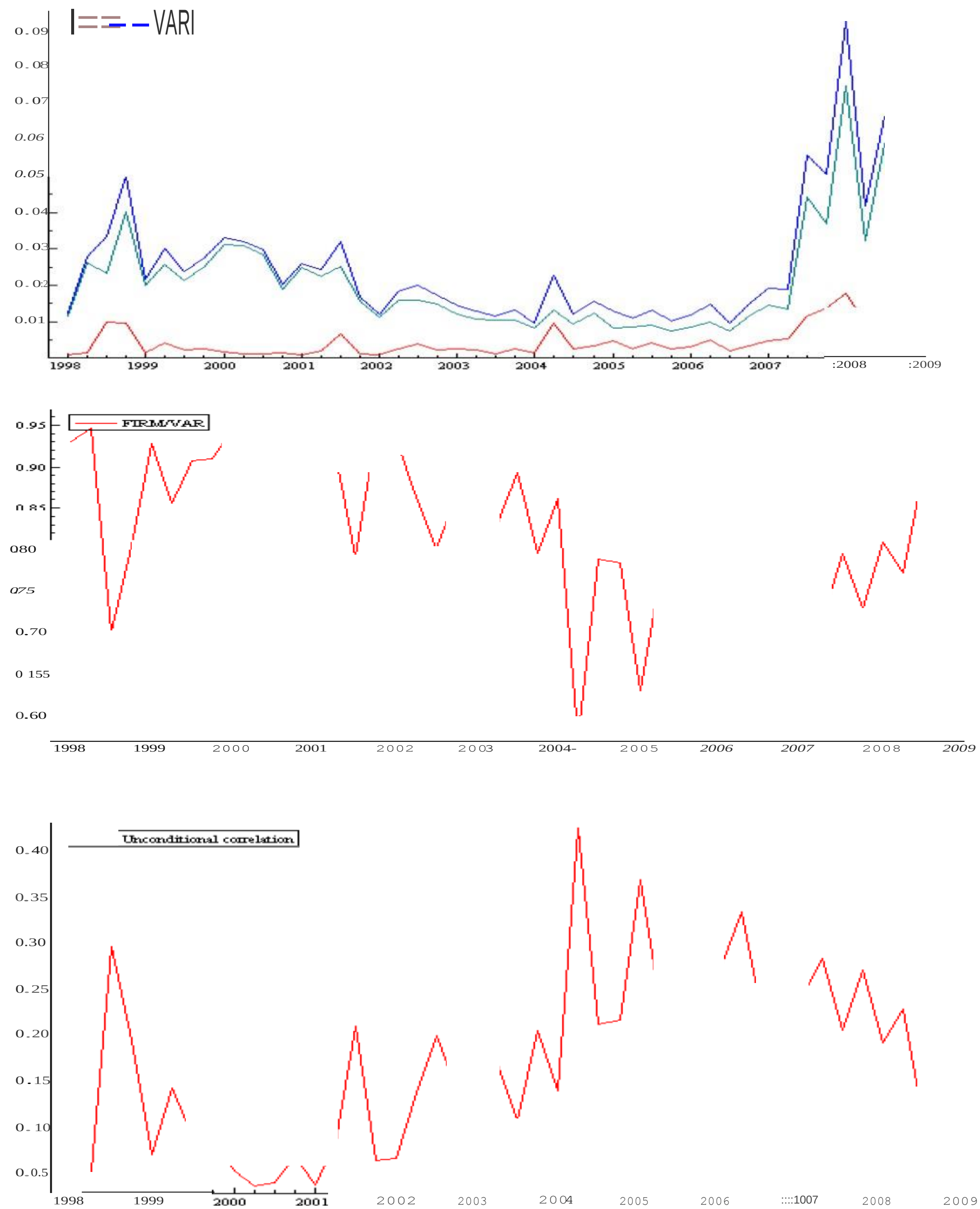
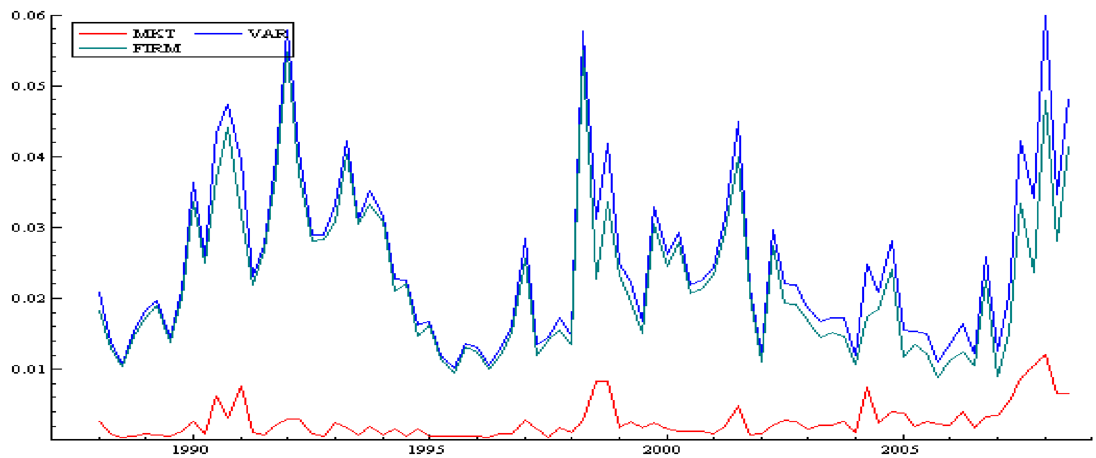
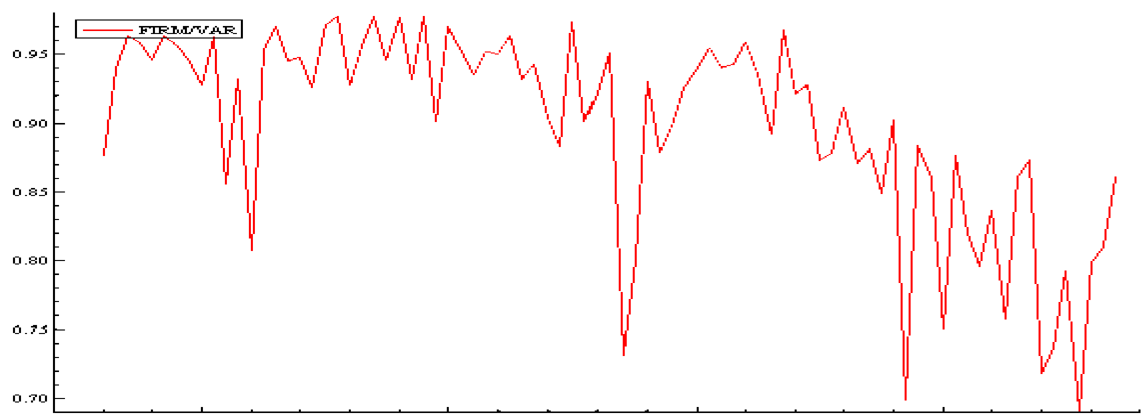


Exhibit 7
Total, market and idiosyncratic variances and average correlations of US REITs (Sample B: 1988-2008)

The first plot shows the decomposition of the total variance (VAR) of a US REIT into its market (MKT) and idiosyncratic (FIRM) component. Second is the ratio of FIRM to VAR, followed by a plot of the equally-weighted average correlation amongst the 40 REITs





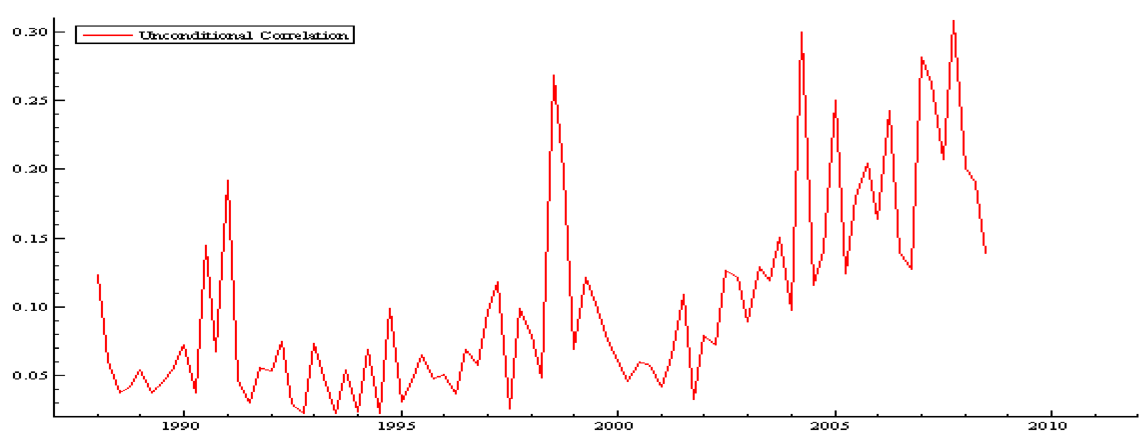


Exhibit 8 Descriptive statistics of the volatility and average correlation series

This table provides the average time-series statistics of individual REIT's total variance (VAR), market variance (MKT), idiosyncratic variance (FIRM) and correlation among the individual firms (CORR) for the two research samples (Sample A: 1998-2008; Sample B: 1988-2008). All estimates are derived following CLMX (2001)'s unconditional methodology. The time-series statistics of individual stocks' MKT and FIRM are first computed and then the mean statistics across all REITs.

Panel A: Univariate Summary Statistics

Sample	No of REITs	Variable	Mean (%)	S.D. (%)	Coefficient of variation (CV)	Autocorrelation at lags (week)								
						1	2	3	4	5	6	8	10	12
A	122	MKT	0.032	0.068	2.125	0.215	0.150	0.090	0.092	0.106	0.141	0.097	0.133	0.151
		FIRM	0.157	0.214	1.363	0.304	0.252	0.141	0.134	0.121	0.103	0.112	0.109	0.105
		VAR	0.189	0.252	1.333	0.349	0.252	0.128	0.161	0.131	0.138	0.110	0.116	0.142
		CORR	14.39	15.95	1.108	0.128	0.123	0.146	0.201	0.134	0.083	0.100	0.143	0.091
B	40	MKT	0.020	0.042	2.100	0.224	0.153	0.116	0.106	0.109	0.113	0.134	0.144	0.178
		FIRM	0.172	0.173	1.006	0.355	0.154	0.132	0.146	0.086	0.100	0.106	0.141	0.166
		VAR	0.191	0.192	1.005	0.373	0.162	0.128	0.147	0.079	0.106	0.117	0.143	0.175
		CORR	9.30	12.14	1.305	0.165	0.182	0.194	0.174	0.164	0.105	0.079	0.126	0.139

Panel B: Comparison of average variance and correlation estimates across two different REIT periods (1988-1992; 1993-2008) in Sample B

As Sample B cut across two different phases of the USA REIT market development, we compare two sets of volatility results: one for the vintage REIT era (1988-1992), and the other for the new REIT era (1993-2008), as the year 1993 is widely regarded as the point at which the REIT market experiences a structural change (Glascock et al., 2000).

REIT sub-period	Weekly average			
	MKT (%)	VAR (%)	FIRM (%)	CORR
Vintage REIT era (1988-1992)	0.0155	0.221	0.205	0.0590
New REIT era (1993-2008)	0.0212	0.182	0.161	0.0726
ANOVA parametric F-stat (p value)	3.501 (0.062)	8.066 (0.005)	12.942 (0.000)	27.394 (0.000)
Wilcoxin non-parametric Z-stat (p value)	-1.556 (0.117)	-5.329 (0.000)	-6.439 (0.000)	-3.905 (0.000)

Panel C: Correlations among volatility measures

	VAR		MKT		FIRM	
	1998-2008	1988-2008	1998-2008	1988-2008	1998-2008	1988-2008
VAR	1	1	0.647	0.509	0.970	0.980
MKT	-	-	-	-	0.442	0.317

Exhibit 9
Testing of random walk hypothesis for market variance (MKT) and idiosyncratic variance (FIRM)

To test the random walk hypothesis for MKT and FIRM, this table presents statistics of the estimations from the time-series regressions in which the changes in the average MKT and FIRM estimates are regressed on the level of average MKT/ FIRM estimates in the previous week. Similar examinations on Ln(MKT/FIRM) are also conducted. The t-statistics are compared with the Augmented Dickey-Fuller (ADF) critical values to examine whether the null hypothesis of a random walk is rejected. The two time series regression models are:

Model 1: $MKT_{t+1} - MKT_t = \varphi_0 + \varphi_1 MKT_t + \varepsilon_t; FIRM_{t+1} - FIRM_t = \varphi_0 + \varphi_1 FIRM_t + \varepsilon_t; t = 1,2....T$

Model 2: $LnMKT_{t+1} - \ln MKT_t = \varphi_0 + \varphi_1 LnMKT_t + \varepsilon_t; LnFIRM_{t+1} - \ln FIRM_t = \varphi_0 + \varphi_1 LnFIRM_t + \varepsilon_t; t = 1,2....T$

	Sample A		Sample B	
	φ_1	$t(\varphi_1)$	φ_1	$t(\varphi_1)$
MKT	-0.770	-15.55	-0.674	-4.45
LN(MKT)	-1.464	-45.83	-1.551	-29.32
FIRM	-0.683	-9.92	-0.631	-9.57
LN(FIRM)	-0.399	-10.25	-1.384	-51.63
ADF 5% critical values	-2.86 (intercept); -3.41 (intercept and trend)			

Exhibit 10 Time Trends

This table reports estimates of a deterministic time trend for the variance and correlation series: VAR (total variance); MKT (market variance), FIRM (idiosyncratic variance) and CORR (average correlations). All the series are estimated as defined in the text. REITNEW dummy is an indicator variable for the new REIT era which is equal to 1 for all weeks during 1993-2008). S0708 dummy is an indicator variable for the global financial crisis (which is still undergoing) which is equal to 1 for all weeks during October 12, 2007 –September 26, 2008 (inclusive). S0003 dummy is an indicator variable for the US stock market downturn which is equal to 1 for all weeks during September 1, 2000 – March 14, 2003. In Panels A and B, number in parenthesis are the t-statistics based on Newey and West standard errors and covariance. In Panel C, we provide *t-PS* using Vogelsang's (1998) robust trend test. Coefficients on time trend and dummy indicators that are statistically significant at least at the 5 percent level are in bold.

Panel A: Sample A (1998-2008)

Explanatory variables	Dependent variable			
	FIRM	MKT	VAR	CORR
Intercept	0.0014 (6.02)	0.0019 (2.27)	0.0017 (4.38)	0.065 (4.16)
Lag_1	0.179 (2.05)	0.162 (2.88)	0.255 (2.30)	0.0174 (0.32)
Lag_2	0.144 (1.85)	-	-	-
TREND	**-1.66 ($x10^{-6}$)** (-2.37)	2.12 ($x10^{-7}$) (0.81)	-1.61($x10^{-6}$) (-1.56)	**0.000323** (5.62)
S0003 (dummy)	-0.000109 (-0.89)	-8.62 ($x10^{5}$) (-1.51)	-0.000185 (-1.13)	**-0.0424** (-2.93)
S0708 (dummy)	**0.00232** (3.39)	**0.00046** (2.88)	**0.00289** (3.08)	-0.0594 (-1.92)
Adjusted R^2	0.189	0.098	0.108	0.110

Panel B: Sample B (1988-2008)

Explanatory variable	Dependent variable			
	FIRM	MKT	VAR	CORR
Intercept	0.0014 (8.94)	9.23 ($x10^{5}$) (3.97)	0.0015 (8.88)	0.032 (4.89)
Lag_1	0.333 (7.40)	0.157 (2.38)	0.351 (8.76)	0.0365 (0.76)
TREND	-3.86 ($x10^{-7}$) (-1.51)	**2.69 ($x10^{-7}$)** (3.51)	-1.65($x10^{-7}$) (-0.63)	**0.000187** (8.30)
REITNEW (dummy)	-0.00018 (-0.92)	**-0.00011** (-2.41)	-0.00025 (-1.24)	**-0.050** (-4.39)
S0003 (dummy)	0.00022 (1.50)	-5.98 ($x10^{5}$) (-1.75)	0.00017 (1.06)	**-0.0410** (-3.04)
S0708 (dummy)	**0.00103** (3.07)	**0.0003** (2.97)	**0.00124** (3.33)	-0.0131 (-0.49)
Adjusted R^2	0.145	0.108	0.156	0.134

Panel C: Vogelsang (1998) size-robust trend test

$$FIRM_t = \alpha + \beta * TREND + \varepsilon_i$$

95% critical value for t-PS = 1.7100

Dependent variable	β	t-PS
Sample A (1998-2008)		
MKT	0.0000	0.6875
VAR	0.0000	-0.6716
FIRM	0.0000	-0.9515
CORR	**0.0003**	3.3719
Sample B (1988-2008)		
MKT	0.0000	1.2041
VAR	0.0000	-0.9262
FIRM	0.0000	-1.2074
CORR	**0.0001**	2.2793

Exhibit 11 Results of Granger Causality Tests

This table report Granger Causality Test results between market variance (MKT) and average firm-level variance (FIRM).The appropriate lag length is 1 using the Akaike Information Criterion (AIC) and the Swartz Bayesian Criterion (SBC).

Dep. Variable	Lags	F-Statistic	Sig.
Sample A (1998-2008)			
Unconditional series			
MKT_T	$FIRM_{T-q}$	15.03	.000
$FIRM_T$	MKT_{T-q}	14.75	.000
Sample B (1988-2008)			
Unconditional series			
MKT_T	$FIRM_{T-q}$	13.14	.000
$FIRM_T$	MKT_{T-q}	*6.97*	.008

Exhibit 12
Short Run Volatility Components Variance Decomposition Model

This table reports the VAR system of market variance (MKT) and average firm-level variance (FIRM), the percentage of the variance of the series reported in the first column explained by the series reported at the top of each row.

Series	St. Error	Week	MKT	FIRM
Sample A (1998-2008)				
MKT	6.58($x10^{-4}$)	1	100.0	0.0
	6.82 ($x10^{-4}$)	2	97.68	2.32
	6.86 ($x10^{-4}$)	3	97.33	2.67
	6.86 ($x10^{-4}$)	4	97.28	2.72
	6.86 ($x10^{-4}$)	8	97.27	2.73
	6.86 ($x10^{-4}$)	12	97.27	2.73
FIRM	2.01 ($x10^{-3}$)	1	14.85	85.16
	2.14 ($x10^{-3}$)	2	19.85	80.15
	2.15 ($x10^{-3}$)	3	20.54	79.46
	2.16 ($x10^{-3}$)	4	20.64	79.3
	2.16 ($x10^{-3}$)	8	20.64	79.36
	2.16 ($x10^{-3}$)	12	20.65	79.35
Sample B (1988-2008)				
MKT	4.12 ($x10^{-4}$)	1	100.0	0.0
	4.23 ($x10^{-4}$)	2	99.45	0.55
	4.24 ($x10^{-4}$)	3	99.31	0.69
	4.25 ($x10^{-4}$)	4	99.28	0.72
	4.25 ($x10^{-4}$)	8	99.28	0.72
	4.25 ($x10^{-4}$)	12	99.28	0.72
FIRM	1.61 ($x10^{-3}$)	1	7.39	97.61
	1.72 ($x10^{-3}$)	2	10.07	89.93
	1.74 ($x10^{-3}$)	3	10.61	89.39
	1.74 ($x10^{-3}$)	4	10.66	89.30
	1.74 ($x10^{-3}$)	8	10.71	89.29
	1.74 ($x10^{-3}$)	12	10.71	89.29

Exhibit 13 Dynamic relations between market return and volatility- Sample A (1998-2008)

Panel A of the table presents the simple contemporaneous correlations between the realized average return (RET), market variance (MKT) and firm variance (FIRM) and between the realized average return (RET), market volatility (IVOL – defined as the square root of MKT) and idiosyncratic volatility (IVOL – defined as the square root of FIRM). Panel B reports the coefficient estimates and t –statistics based on Newey and West standard errors and covariance (in parenthesis) from the six regressions where the dependent variables are the average returns. S0708 dummy is an indicator variable for the global financial crisis (which is still undergoing) which is equal to 1 for all weeks during October 12, 2007 –September 26, 2008 (inclusive). S0003 dummy is an indicator variable for the US stock market downturn which is equal to 1 for all weeks during September 1, 2000 – March 14, 2003. All the variance and volatility series are linearly de-trended. Coefficients on variance/volatility that are at least statistically significantly at the 10 percent level are bolded.

Panel A Simple contemporaneous correlations

	FIRMT	MKT
RET	-0.178	-0.301
	IVOL	IMKT
RET	-0.160	-0.212

Panel B Relations between average returns and lagged one-period variance/volatility variables

Model	Intercept	Lag(FIRM)	Lag(MKT)	Lag(IVOL)	Lag(IMKT)	S0003 (Dummy)	S0708 (Dummy)	Adjusted R^2
1	0.0018 (1.81*)	0.2046 (0.33)	-	-	-	0.001 (0.61)	-0.0076 (-1.89*)	0.0182
2.	0.0017 (1.77*)	-	-1.1629 (-0.61)	-	-	0.0009 (0.60)	-0.0067 (-1.71*)	0.0164
3	0.0018 (1.86*)	0.4099 (0.59)	-1.6533 (-0.82)	-	-	0.0009 (0.55)	-0.0075 (-1.87*)	0.0182
4	0.0018 (1.72*)	-	-	0.0008 (0.10)	-	0.0010 (0.62)	-0.0072 (-1.69*)	0.0147
5	0.0017 (1.80*)	-	-	-	-0.1183 (-1.28)	0.0008 (0.53)	-0.0064 (-1.67*)	0.0205
6	0.0018 (1.86*)	-	-	0.0440 (0.53)	-0.1404 (-1.47)	0.0007 (0.44)	-0.0073 (-1.76)	0.0216

Exhibit 14 Dynamic relations between average return and volatility- Sample B (1988-2008)

Panel A of the table presents the simple contemporaneous correlations between the realized average return (RET), market variance (MKT) and firm variance (FIRM) and between the realized average return (RET), market volatility (IVOL – defined as the square root of MKT) and idiosyncratic volatility (IVOL – defined as the square root of FIRM). Panel B reports the coefficient estimates and t –statistics based on Newey and West standard errors and covariance (in parenthesis) from the various regressions where the dependent variables are the average returns. REITNEW dummy is an indicator variable for the new REIT era which is equal to 1 for all weeks during 1993-2008). S0708 dummy is an indicator variable for the global financial crisis (which is still undergoing) which is equal to 1 for all weeks during October 12, 2007 –September 26, 2008 (inclusive). S0003 dummy is an indicator variable for the US stock market downturn which is equal to 1 for all weeks during September 1, 2000 – March 14, 2003. All the variance and volatility series are linearly de-trended. Coefficients on variance/volatility that are at least statistically significantly at the 10 percent level are bolded.

Panel A Simple contemporaneous correlations

	FIRM	MKT
RET	-0.00128	-0.1354
	IVOL	IMKT
RET	0.01128	-0.1354

Panel B Relations between average returns and lagged one-period variance/volatility variables

Model	Intercept	Lag(FIRM)	Lag(MKT)	Lag(IVOL)	Lag(IMKT)	REITNEW (Dummy)	S0003 (Dummy)	S0708 (Dummy)	Adjusted R^2
1	0.0008 (0.70)	**0.5283** (1.77*)	-	-	-	0.0017 (1.33)	-0.0003 (-0.21)	-0.0068 (-2.26**)	0.0157
2.	0.0009 (0.80)	-	-0.2967 (-0.17)	-	-	0.0015 (1.15)	-0.0002 (-0.11)	-0.0062 (-1.85*)	0.0115
3	0.0009 (0.75)	**0.6280** (1.82*)	-1.098 (-0.59)	-	-	0.0017 (1.26)	-0.0004 (-0.29)	-0.0067 (-2.07**)	0.0156
4	0.0008 (0.70)	-	-	**0.0563** (1.76*)	-	0.0018 (1.33)	-0.0004 (-0.25)	-0.0071 (-2.26**)	0.0151
5	0.0010 (0.86)	-	-	-	-0.0547 (-0.81)	0.0014 (1.04)	-0.0002 (-0.88)	-0.0059 (-1.83*)	0.0127
6	0.0009 (0.81)	-	-	**0.0764** (2.16**)	-0.0962 (-1.36)	0.0016 (1.22)	-0.0006 (-0.44)	-0.0064 (-2.14**)	0.0227