THE PRICING OF VOLATILITY RISK IN CROSS-SECTIONAL EQUITY REIT RETURNS

by

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Abstract

This study examines the pricing of volatility risk in the cross-sectional equity Real Estate Investment Trust (REIT) stocks returns over the 2002-2014 period. The volatility risk of stock returns is decomposed into systematic volatility and idiosyncratic volatility.

We estimate the systematic risk by the residual of VIX after applying GARCH (1,1). We estimate idiosyncratic risk by using the residual from Fama and French three-factor model.

Overall, we conclude that neither systematic volatility nor idiosyncratic volatility are directly priced in the equity REIT returns over time.

Keywords: Equity REITs returns; Pricing; Systematic volatility; Idiosyncratic volatility; Fama-French Model.

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1. Introduction

As the modern portfolio theory suggests, the inclusion of alternative investments can provide useful diversification benefits to a traditional portfolio including only bonds and stocks. Compared with other major types of alternative investments, Real Estate Investment Trust (REIT), which issues shares just as shares of stocks on the listed exchanges, offers much higher liquidity. REITs enable investors to invest in different types of real estate in the form of stock. By dividing high-value pieces of real estate into single tradable shares, small investors with limited capital can also have access to this type of investment, which originally only large institutions and the wealthy could. Historically, REITs provide investors returns mostly in the form of dividends. Over the past 20 years ended December 31, 2014, listed U.S. REITs produced a compound annual total return of 11.1%, higher than the S&P 500's 9.8%. In 2014, listed U.S. REITs paid out $41 billion in dividends. *(Data source: https://www.reit.com/)*

As an investment vehicle, REITs not only provide a low barrier to get the exposure to the real estate market as an effective means of diversification to the equity and bond markets, but also attractive returns. Therefore, we want to study on the unique risk and return profile of equity REIT, which is similar to normal stocks in the form but different in nature, to understand how return is correlated with its risk and therefore to provide implications on how to optimize the formation of our investment portfolio.

There are many discussions about whether REIT equities behave like typical stocks or the underlying real estate assets. As suggested by both theories and empirical studies, stock returns do not compensate for the idiosyncratic risks, which can be diversified away. Therefore, only systematic risk is priced. However, due to the distinct characteristics of equity REITs, which might lead to more exposure to idiosyncratic risk for REITs than typical stocks, and suggested by previous literature that the systematic risks is not priced in equity REITs, we are motivated on the pricing of volatility risks by ourselves.

Theories argue that as the idiosyncratic risk cannot be diversified, investors demand compensation for idiosyncratic risk and then agents would require a risk premium on stocks with higher idiosyncratic risk (see Malkiel and Xu (2002) and Jones and Rhodes-Kropf (2003)). So, high exposure to idiosyncratic risk tends to produce higher expected returns. If the Fama-French model works for equity REITs, forming portfolios by ranking the firms by idiosyncratic volatility will return no difference in average returns. Following this logic, we form long-short portfolios with a positive exposure to idiosyncratic volatility.

Our paper analyses the equity REIT returns over the period of 2002-2014. We divide the whole sample period into three sub-periods: pre-crisis period (2002-2006), crisis period (2007-2009), post-crisis period (2010-2014). The way of this separation follows Prashant K. Das (2014). We then examine the pricing of systematic volatility risk and idiosyncratic volatility risk for each sub-sample period independently. We conclude that Fama-French model does not apply for equity REITs before the 2007 crisis, when return is negative and significant different from zero. Some earlier studies also find the same result as us. For example, R. Jared DeLisle, S. McKay Price, and C.F. Sirmans (hereafter RSC) (2013) also find that idiosyncratic risk is negative and significant related to the REIT returns. However, after the 2007 crisis, we find different result that the there is no significant relation between the idiosyncratic risk and the REIT equity returns.

Our results show that aggregate volatility risk is not priced in REIT returns. The conclusion is distinct from AHXZ (2006) using same methodology, but on non-REIT stock returns, where they find a negative and highly significant aggregate volatility risk premium in non-REIT stock returns. However, this result is consistent with previous studies on equity REITs, which further strengthen the idea that unlike the pricing of normal stocks, the pricing of equity REITs is highly independent of market risk.

On the other hand, we conclude that the relationship between idiosyncratic volatility and the equity REIT returns changed after the 2007 crisis. This is in sharp contrast with the Ooi, Wang, and Webb (hereafter OWW) (2009), who find that idiosyncratic risk is positively priced. His result is actually consistent with economic theories that suggest that idiosyncratic should be positively priced because risk-averted investors demand a premium to compensate for the risk that cannot be fully diversified.

Overall, our study mainly makes two contributions to the literature on REITs and volatility risk. First, we demonstrate that REITs are not sensitive to innovations in systematic volatility in the equity REIT returns using the implied market-wide volatility VIX. In other words, the systematic risk is not priced in equity REIT returns. Second, by using a well-recognized empirical method to study the idiosyncratic risk, we do find a significant negative relation between the equity REIT idiosyncratic volatility and returns for sub-sample period of 2002-2006 (the pre-crisis period). However, when we split and extend the period, we find the relationship no longer works during the crisis period and post-crisis period.

2. Literature Review

While modern portfolio theory suggests that if diversification is free, only systematic price would be priced. In reality, this assumption does not hold. Barber and Odean (2000) and Benartzi and Thaler (2001) provide empirical evidence that investors tend to hold insufficiently diversified portfolio in order to limit transaction costs. Therefore, it is necessary to investigate in the pricing of not only the market risk but also the idiosyncratic risk. It suggests that market risk and idiosyncratic risk together determine the cross-sectional differences in returns (Basu (1977), Banz (1981), Jegadeesh (1990)). Merton (1978) thinks that investors concern about total risk if they cannot invest in the market portfolio.

Until now, there are many studies on the importance of pricing of idiosyncratic risk in cross-sectional stock returns and the time-series predictability of returns, especially for alternative investment with distinct characteristics from bonds and stocks. Chaudhry, Maheshwari and Webb (2004) find that unique REIT characteristics raise an understanding of idiosyncratic risk to be of great importance.

For typical stocks, many researches find positive relationship between idiosyncratic risk and stock returns (Lehmann (1990)). Malkiel and Xu (2002) shows that idiosyncratic risk is significantly positive related to the cross-sectional returns. Spiegel and Wang (2005) expected stock returns are positive to the idiosyncratic risk and negative to the liquidity of stocks. By contrary, Ang, Hodrick, Xing and Zhang (2006) find a strong negative relationship between idiosyncratic risk and average returns, not only for cross-sectional US stocks but also in international stock market.

REIT idiosyncratic risk gathered the attention of researchers only since OWW (2009) states that the property-related nature of real estate lead to more exposure to idiosyncratic risk for REITs than typical stocks. OWW (2009) also find that idiosyncratic risk is positive priced in REIT returns. OWW use exponential generalized auto-regressive conditional heteroscedasticity (EGARCH) models to estimate the firm-specific volatility, which introduce a look-ahead bias.

Chiang, Jiang, and Lee (2009) (hereafter CJL) find mixed results. They show a positive relationship between idiosyncratic risk and REIT returns for pre-1992 period and a negative relationship for post-1992 period. Sun and Yung (2009) (hereafter SY) states that they initially find a positive relation between idiosyncratic risk and equity REIT returns, but the positive relation become insignificant any more once incorporating about various controls. In contrast to the previous studies, RSC (2013) used Fama and French three-factor model to estimate the idiosyncratic risk of equity REITs and find that it is significantly negative related to the cross-sectional REIT returns over the sample period of 1996-2010.

3. Data Sources

Our sample includes all the Constituent Companies of the FTSE NAREIT Equity REITs Index. We examined the sample over the period of 2002-2014. We obtain the daily VIX index data from Chicago Board Options Exchange (CBOE) website. Our data of daily and monthly returns, share prices, and shares outstanding are downloaded from the Center for Research in Security Prices (CRSP). Ken French's website provides updated data on related Fama and French model, including the risk-free rate (Rf), Market excess returns (MKT), Size factor (SMB) and Book-to-market factor (HML). Observations with negative price data and with incomplete annual daily returns are deleted. In this way we ensure we have a complete daily returns for every company each year. This data processing method might not give a very complete set of equity REITs data, but a simplified way to pursue and unlikely to influence the result.

4. Methodology

Overall, we follow the template paper of R. Jared DeLisle, S. McKay Price, and C.F. Sirmans (hereafter RSC) (2013) closely in terms of methodology.

We obtain the prices and returns of the listed equity REITs on each year over the period 2002-2014 on both daily and monthly basis. We also get the daily and monthly data related to Fama-French three-factor model and VIX index over the same period.

Market beta is criticized of its limitation in estimating the systematic risk and failure to capture stochastic volatility. To avoid the potential limitations of market beta, we follow the methods of Ang, Hodrick, Xing, and Zhang (hereafter AHXZ) (2006, 2009), to use measures of aggregate volatility, in our case the CBOE market volatility index (VIX index), to capture the implied market volatility.

First, we apply a GARCH (1, 1) filter on the VIX index daily data in order to get the innovations of VIX. The innovations of VIX in GARCH (1, 1) are denoted as ΔVIX, which is used to measure the systematic volatility. We then run regression of the excess equity REIT daily returns on the excess market returns (denoted as MKT) and ΔVIX. We then get the factor loadings of MKT and ΔVIX. The factor loadings of ΔVIX, $\beta_{\Delta VIX}$ are used as the sensitivity to innovations in implied market volatility.

Secondly, we apply Fama-French three-factor model to obtain the idiosyncratic volatility. We run regression of the excess equity REIT return on the excess market returns (MKT), SMB and HML. We get the residuals from the regression. We then calculate the standard deviation of the residuals as the proxy as the idiosyncratic volatility (denoted as IVOL).

Thirdly, for each month, we sort firms by $\beta_{\Delta VIX}$ and IVOL independently. Then, we separate firms into quintile portfolios from lowest $\beta_{\Delta VIX}$ or IVOL to highest $\beta_{\Delta VIX}$ or IVOL. A long-short portfolio of equity REITs is also created every month by taking a short position on lowest quintile firms and taking a long position on highest quintile firms. In order to do further analysis, we apply Fama and French three-factor model on the long-short portfolio returns to get alphas.

Compared to RSC (2013), we extend the sample period from 1996-2010 to 2002-2014, and separate the period into pre-crisis (2004-2006), crisis (2007-2009), post-crisis (2010-2014). We have successfully replicated the result during the sub-period (2002 - 2006) of their whole sample period (1996-2010). Consistent with their conclusion, we find that equity REIT idiosyncratic volatility is negatively priced in returns in period of 2002-2006. The P-value during 2002-2006 is 0.011, and the coefficient beta IVOL is negative, therefore suggesting that the negative relationship is significant.

However, we find the relationship disappear using a more recent sample. And for the whole study period of 2002-2014, the relationship is also insignificant. Therefore, we conclude that IVOL is no longer priced during the crisis and after the crisis.

We use the actual time series innovations of VIX as the proxy for market volatility. We applied GARCH filter on VIX and obtained the standardized residuals (Denoted by ΔVIX) from the time series of VIX index. We use the innovations of VIX data as the input for our regression for the excess return of the REIT returns (RET) on the Market excess return (MKT) and systematic volatility (ΔVIX) factors.

We then regress returns of the equity REITs on the MKT and ΔVIX month-by-month using daily returns to obtain the firm sensitivity to innovations in implied market volatility, denoted as $\beta_{\Delta VIX}$.

$$RET_{i,t} = \alpha_i + \beta_{MKT,i}\mathrm{MKT}_t + \beta_{\Delta VIX,i}\mathrm{Volatility}_t + \varepsilon_{i,t}$$

For the idiosyncratic volatility, we follow AHXZ (2006, 2009). It is computed from the Fama and French (1993) three-factor model

$$RET_{i,t} = \alpha_i + \beta_{MKT,i}\mathrm{MKT}_t + \beta_{SMB,i}\mathrm{SMB}_t + \beta_{HML,i}\mathrm{HML}_t + \varepsilon_{i,t}$$

Regress on the Fama-French model, we obtain residuals. We calculate the standard deviation of the residuals as idiosyncratic volatility denoted as IVOL. One of the advantages of this technique is avoiding introducing a look-ahead bias in the calculation of idiosyncratic volatility.

$$IVOL = \left(\frac{1}{N}\sum_{t=1,N}\varepsilon_{i,t}^2\right)^{1/2}$$

5. Analysis and Results

For each month, we separately rank firms by $\beta_{\Delta VIX}$ and IVOL. $\beta_{\Delta VIX}$ is the firm sensitivity to innovations in implied market volatility. IVOL represents the idiosyncratic volatility. After the rankings, firms are sorted into quintile portfolios from lowest to highest. Then, following the method of RSC (2013), we generate long-short portfolios where we long the firms in highest quintile (5) and short the firms in the lowest quintile (1). Since we assume that investors use historical information to adjust their portfolios, equally weighted portfolio returns are then calculated using the following month returns. In order to further study the long-short (5-1) portfolio returns, we do regression of the 5-1 portfolio excess returns on the Fama-French (1993) three-factor model and obtain the alpha, for both cases respectively. To examine the impact of 2007 Crisis in US, we divide our sample period into Pre-crisis (2002-2006), Crisis (2007-2009) and Post- crisis (2010-2014). The way of period separation follows Prashant K. Das.

Table 3 shows equally weighted monthly returns of quintile portfolios and 5-1 portfolios. In the idiosyncratic volatility case (IVOL columns), for the pre-crisis period, from 2002 to 2006, the long-short (5-1) portfolio monthly returns are negative and significant at 90% confidence level. The Fama and French (1993) alpha is negative -0.68% and highly significant as well. We can say that the idiosyncratic risk is priced in the REIT returns. This pre-crisis result is consistent with the result of RSC (2013) where the alpha is significant and the 5-1 portfolio returns are negative but not significant. In RSC (2013), they used the period of 1996 to 2010. However, the 5-1 portfolio returns and alphas are not significant for the whole sample period, crisis period and post-crisis period. Therefore, the pricing of idiosyncratic risk presents different results for different sample period. In other words, the idiosyncratic risk is no longer priced in the returns of REIT returns after the 2007 crisis. There is an interesting phenomenon that the p-value of alpha in crisis period is up to 0.99 (highly not significant), compared to 0.37 for post-crisis period and 0.15 for the whole sample period.

In Table 4, excess returns are regressed on idiosyncratic volatility (IVOL) and firm sensitivity to systematic volatility respectively over the whole sample period (from 2002-2014). We use Fama-MacBeth (1973) regression and use the t-stat to test whether the coefficients and intercepts are different from zero. The positive and insignificant (at the 5% level) coefficient on IVOL is contrary to the result in RSC (2013) where the coefficient is negative and significant. Hence, for the period of 2002-2014, the idiosyncratic risk is not negatively related to the returns of equity REITs.

For the implied market volatility case, in Table 3 $\beta_{\Delta VIX}$ columns, the 5-1 portfolio monthly returns are not significant different from zero. This is contrary to the highly significant portfolio returns differences for non-REIT equities in AHXZ (2006). The Fama and French (1993) alphas are insignificant as well. So, different from non-REIT equity returns, REIT equity returns are not related to systematic risk. In Table 4, the coefficient of Fama-MacBeth regression of RET on $\beta_{\Delta VIX}$ (regression [2]) is negative and insignificant. This result is consistent with the portfolio-level sorts in Table 3. It suggests that the systematic risk is not priced in equity REIT returns.

6. Conclusion

This study examines whether volatility risk, both systematic risk and idiosyncratic risk is priced in the cross-sectional returns of US equity REITs.

We find that systematic volatility is not priced in equity REIT stocks. This result holds across the pre-crisis, crisis, post-crisis period and the whole sample period. None of 5-1 alphas in $\beta_{\Delta VIX}$ case is significant (in Table 3) and coefficient of $\beta_{\Delta VIX}$ in the Fama-MacBeth regression is not significant as well (in Table 4). Compared to the result in AHXZ (2006) and DS (2011), which suggests that the systematic volatility is priced for non-REIT equities, our result implies that the systematic volatility is not priced for equity REITs. This finding is important to portfolio hedging. Investors can use equity REITs to hedge their portfolio against innovations in market volatility.

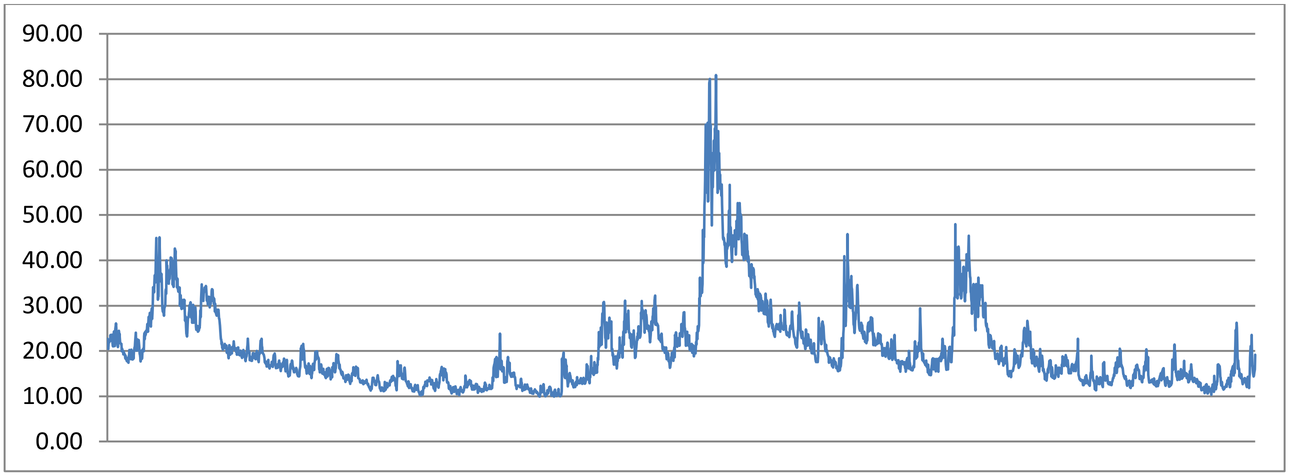
In the idiosyncratic volatility case, we conclude that idiosyncratic volatility is negatively priced in the pre-crisis period (2002-2006), which is consistent with the result of RSC (2013) over the period of 1996-2010. However, after 2007, the relationship does not continue anymore. The idiosyncratic risk is not significantly priced in the equity REIT returns.

Overall, we conclude that neither systematic volatility nor idiosyncratic volatility have direct impact on the equity REIT returns over time.

Appendices

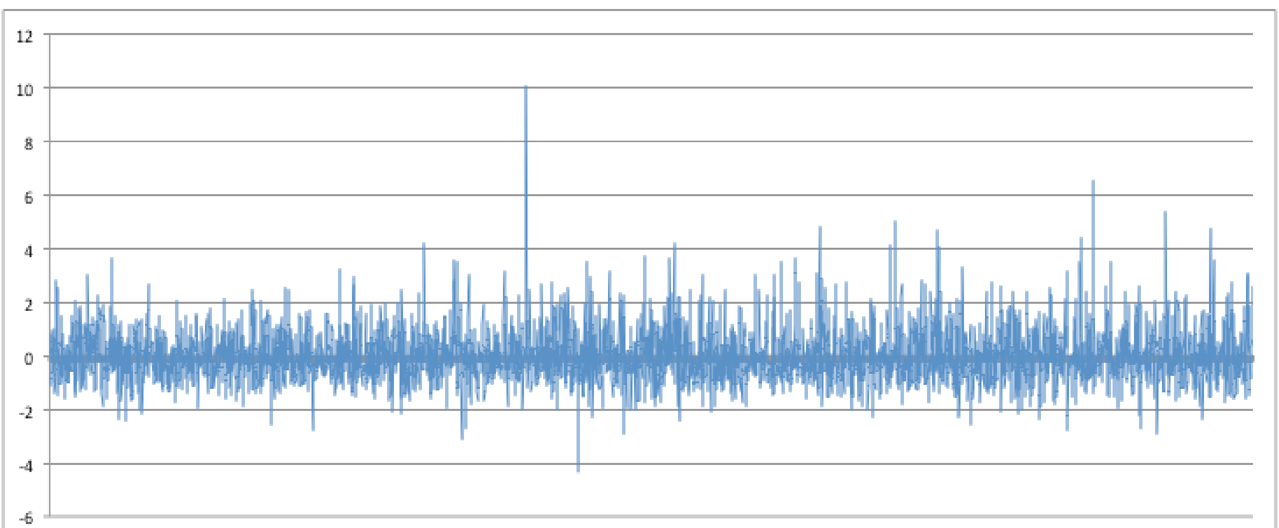
Figure 1: Daily VIX and Daily ΔVIX (from 2002-2014)

VIX



Notes: VIX is the CBOE market volatility index shown on a daily basis over the 2002-2014 sample period.

ΔVIX



Notes: ΔVIX is the innovations of GARCH (1,1) applied to VIX; Daily Implied Market Volatility as Measured by ΔVIX

Table 1: Descriptive Statistics

Variables	Obs.	Mean	Std.dev	Median
RET(monthly)	20,274	0.012	0.1014	0.0148
ΔVIX	3,273	0.006	1.019	-0.11339
IVOL	20,274	1.48	1.4566	1.0662

Table 2: Correlation

	RET(monthly)	β_{MKT}	$\beta_{\Delta VIX}$	IVOL
RET(monthly)	1			
β_{MKT}	-0.104	1		
$\beta_{\Delta VIX}$	0.057	-0.067	1	
IVOL	0.016	-0.057	0.281	1

Table 3: Monthly Portfolio Returns Sorted by Sensitivity to Volatility Measures

(pre-crisis, crisis, post-crisis, whole period)

Pre-crisis (2002-2006)				
	$\beta_{\Delta VIX}$		**IVOL**	
Quintiles	**Pre-formation Mean**	**Post-formation Returns %**	**Pre-formation Mean**	**Post-formation Returns %**
1(low)	-0.276	0.929	0.664	1.662
2	0.013	0.947	0.862	1.508
3	0.187	0.835	1.007	1.309
4	0.369	0.720	1.198	1.421
5(high)	0.919	0.775	2.105	1.510
5-1		0.015		-0.436*
(tstat)		(0.817)		(-1.7784)
FF3-α		0.34		-0.68**
(tstat)		(1.297)		(-2.62)

Crisis (2007-2009)				
	$\beta_{\Delta VIX}$		**IVOL**	
Quintiles	**Pre-formation Mean**	**Post-formation Returns %**	**Pre-formation Mean**	**Post-formation Returns %**
1(low)	-1.201	0.684	2.031	0.746
2	-0.427	0.779	2.509	-0.268
3	-0.031	-0.287	2.823	0.529
4	0.365	-0.333	3.248	-0.395
5(high)	1.218	-0.061	4.399	0.144
5-1		-0.212		-0.003
(tstat)		(-0.29)		(-0.0039)
FF3-α		-0.187		-0.0029
(tstat)		(-0.253)		(-0.004)

Post-crisis (2010-2014)				
	$\beta_{\Delta VIX}$		**IVOL**	
Quintiles	**Pre-formation Mean**	**Post-formation Returns %**	**Pre-formation Mean**	**Post-formation Returns %**
1(low)	-0.179	1.313	0.549	1.467
2	-0.049	1.727	0.689	1.332
3	0.004	1.283	0.819	0.896
4	0.066	1.267	0.977	1.416
5(high)	0.226	1.256	1.672	1.252
5-1		0.196		-0.109
(tstat)		(0.066)		(-0.5172)
FF3-α		0.0365		-0.19
(tstat)		(0.152)		(-0.896)

Whole sample period (2002-2014)				
	$\beta_{\Delta VIX}$		**IVOL**	
Quintiles	**Pre-formation Mean**	**Post-formation Returns %**	**Pre-formation Mean**	**Post-formation Returns %**
1(low)	-0.443	1.337	0.935	1.376
2	-0.061	1.494	1.175	1.031
3	0.143	1.011	1.354	0.970
4	0.357	0.964	1.586	1.000
5(high)	0.956	1.085	2.468	1.096
5-1		-0.0005		-0.21
(tstat)		(0.15)		(-1.0065)
FF3-α		-0.021		-0.297
(tstat)		(-0.099)		(-1.432)

Notes: In month t-1, the RET of each firm is regressed on MKT and ΔVIX on a daily basis to obtain the facor loading $\beta_{\Delta VIX}$ (see equation 1). RET is the daily excess return for each firm. MKT is the daily market returns. ΔVIX is the GARCH (1,1) innovations of VIX, which is the Chicago Board Option Exchange's market volatility index. For idiosyncratic risk, in month t-1, RET is regressed on Fama and French (1993) three-factor model to obtain the standard deviation of residuals denoted as IVOL. In this table, firms are ranked into quintiles based on their respective aggregate market volatility sensitivities $\beta_{\Delta VIX}$ and IVOl. The Pre-formation means are averages of

$\beta_{\Delta VIX}$ and IVOL respectively in each quintile. Post-formation monthly returns are computed as equally-weighted avearges in each quintile portfolio for each month t. 5-1 monthly returns are the returns differences between the highest and lowest quintile portfolios in month t. FF3-α is the alpha from regression of 5-1 portfolio returns on Fama and French (1993) three-factor model.
** $p < 0.10$*
*** $p < 0.05$*
**** $p < 0.01$*

Table 4: Fama-MacBeth Regressions of Excess Equity REIT Returns on Volatility Measures and Controls

Regression of RET on the volatility measures				
	[1]		**[2]**	
	Coeff.	t-stat	Coeff.	t-stat
IVOL	-0.0174	(-1.2615)		
$\beta_{\Delta VIX}$			-0.42	(-0.0728)
Constant	1.39**	(10.01)	1.31**	(2.302)

Table 5: 5-1 Portfolio Monthly Returns of Idiosyncratic Risk (IVOL)

5-1 Profolio Monthly Returns of Idiosyncratic Risk													
	Pre-crisis					Crisis			Post_crisis				
	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002
Feb	-0.00589	0.01457	0.00161	-0.00667	0.01195	-0.10571	-0.00554	-0.00343	-0.02134	0.01424	-0.02797	-0.07175	-0.02706
Mar	0.01054	0.00316	-0.00781	-0.01517	0.01275	-0.02632	0.00314	0.00619	-0.03093	-0.01198	-0.00413	0.01168	0.00577
Apr	-0.00778	0.01106	-0.00141	0.01022	-0.06245	0.17873	-0.00355	-0.01160	-0.00468	-0.01567	-0.00795	-0.00675	-0.00708
May	-0.00480	-0.01218	-0.01586	-0.00126	0.02310	-0.04490	-0.01130	0.01070	0.02243	-0.01702	0.01860	-0.00151	0.03997
Jun	-0.00421	0.01186	0.00337	0.02440	-0.01179	-0.01511	0.03442	-0.02051	0.02169	0.01504	0.00853	-0.01110	0.00638
Jul	0.00308	-0.01360	0.00021	0.00954	0.00992	-0.00350	0.03189	0.02087	-0.00303	0.00574	-0.02425	0.00643	-0.01395
Aug	-0.00426	0.01447	-0.00434	-0.00379	-0.03275	-0.02180	-0.01582	0.00922	0.00325	0.00944	-0.01113	0.01644	0.02030
Sep	0.00404	-0.00215	-0.01234	0.01212	0.00925	0.02122	0.03373	0.00057	0.02248	0.01006	-0.01632	-0.00807	-0.01278
Oct	-0.01690	-0.00950	0.00494	0.01756	-0.01127	0.03806	0.00086	0.00252	0.00256	-0.02654	-0.01394	-0.00677	-0.02105
Nov	0.00844	-0.01073	0.00758	0.01477	-0.02688	-0.01903	-0.04521	0.00740	-0.01688	-0.02818	0.00655	-0.00663	-0.01404
Dec	-0.02108	0.02200	0.01090	0.00912	-0.02953	-0.00117	-0.03282	-0.01313	-0.02031	-0.00586	0.00641	0.00840	-0.00571
Average	-0.109%					-0.003%			-0.436%				

Table 6: 5-1 Portfolio Monthly Returns of Systematic Risk (βΔVIX)

5-1 Profolio Monthly Returns of Systematic Risk													
	Pre-crisis					Crisis			Post_crisis				
	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002
Feb	0.00077	0.00745	0.00653	0.01182	0.04926	-0.08184	0.00108	0.01197	0.01763	0.02326	0.01139	0.01158	-0.05837
Mar	-0.00671	-0.01434	-0.01221	0.01349	0.00028	-0.03723	0.00798	-0.01746	0.04488	0.00576	0.00090	0.00368	0.00512
Apr	-0.01113	0.01491	0.01151	-0.00698	-0.02548	0.15989	-0.01605	0.00630	-0.00660	-0.01750	0.01304	0.01461	0.00016
May	0.00592	0.01593	-0.01227	-0.00415	-0.00699	-0.04131	0.00508	-0.00274	0.01014	-0.00670	0.00550	0.01745	-0.04219
Jun	-0.00570	-0.00777	-0.00172	0.00182	-0.00709	0.00896	-0.01001	0.00488	-0.00798	-0.00681	0.00138	-0.00675	0.00169
Jul	0.03470	-0.00371	0.02197	-0.01484	-0.03065	0.00677	0.02850	-0.00307	-0.00319	0.00451	-0.00835	-0.01449	0.01307
Aug	0.00545	-0.01988	0.00385	0.02578	0.01998	-0.02542	-0.00189	-0.04981	0.02108	0.02182	-0.00743	0.00123	0.01121
Sep	0.00083	-0.00602	0.01253	0.01201	0.00685	0.03697	-0.02015	-0.00729	0.01959	-0.01314	-0.01131	0.01584	-0.00757
Oct	0.03091	0.00383	0.00065	-0.01378	-0.03868	0.02225	-0.01073	-0.03350	-0.01060	-0.00250	0.01508	-0.00859	0.00198
Nov	0.01517	-0.02151	0.00794	-0.01301	-0.01765	0.02379	0.04564	-0.00825	-0.00860	0.03475	-0.01635	-0.01001	-0.00864
Dec	-0.01007	0.00902	0.00597	-0.03001	-0.00670	-0.01295	-0.09248	0.03203	-0.01709	-0.00732	0.00721	0.01246	0.04800
Average	0.015%					-0.212%			0.196%				

Notes: We use the $\beta_{\Delta VIX}$ and IVOL from the regression of daily RET in month t-1 to sort the firms and create the long-short portfolios (5-1 portfolios). These 5-1 portfolios returns are calculated in the month t.

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