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EXISTENCE OF POSITIVE DEPENDENCE, ASYMMETRY AND LEVERAGE EFFECTS IN REAL ESTATE EXCHANGE-TRADED FUNDS (ETFs)

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ABSTRACT

This research examines the performance of return and volatility models containing long-memory, asymmetric volatility, and leverage effects by comparing two categories of Real Estate Investment Trusts (REITs) Exchange-traded Funds (ETFs), namely, US REIT ETFs and Global REIT ETFs. This study utilizes two short-memory models, the autoregressive moving average – exponential generalized autoregressive conditional heteroskedasticity (ARMA-EGARCH); and autoregressive moving average – asymmetric power autoregressive conditional heteroskedasticity (ARMA-APARCH); and two long-memory models, autoregressive fractionally-integrated moving average – fractionally-integrated exponential generalized autoregressive conditional heteroskedasticity (ARFIMA-FIEGARCH); and autoregressive fractionally-integrated moving average – fractionally-integrated asymmetric power autoregressive conditional heteroskedasticity (ARFIMA-FIAPARCH). The study finds presence of volatility clustering, leverage effects and volatility asymmetry phenomena in both US and Global REIT ETFs. Also, long-memory models are better in characterizing future values using lagged returns and volatilities compared to short memory models based on the maximum log-likelihood values. The research also identifies positive long-term dependence in the volatilities of both ETFs, however, fails to conclude dual long memory processes. Nevertheless, the research still can pose a challenge on the weak-form efficient market hypothesis (EMH) of Fama (1970), because historical values of REIT ETFs can still be used to predict their future values. Lastly, US REIT ETFs are seen to be more unstable than their more stationary Global REIT ETFs counterparts. The proper modeling of these ETFs can provide traders, fund managers and investors in creating well-defined trading strategies. Findings can also offer more understanding in the properties of this type of ETFs, and open future channels of research to academicians and researchers.

KEYWORDS
real estate exchange-traded funds, long-memory models, volatility asymmetry and leverage effects.

1. INTRODUCTION

Understanding return and volatility characteristics of real estate investments is crucial because persistent changes in their structures can expose investors to risk when value meltdown occurs. Accurate modeling of volatility in real estate asset returns became a major concern right after the sub-prime mortgage crisis. The recent crisis became the biggest blow to the seem invincible real estate industry in recent years, which also created the so-called 'great recession' that affected other assets worldwide. This spillover to the globalized financial markets made scholars and practitioners more interested in knowing the predictability and asymmetric volatility properties of real estate investments. Other factors affecting returns and volatilities in housing markets include income, interest rates, mortgage credit availability, supply of houses and geographic locations of real estate properties.

Positive dependence or the long-memory process models the presence of a persistent temporal dependence among distant observations, which suggests the predictability of a particular time-series in returns and volatility. On the other hand, the asymmetric volatility property of a data describes the negative correlation between returns and innovations in volatility. This property is commonly connected to the leverage effects property, because negative shocks often are followed by future higher volatility than positive shocks. These data characteristics have been seen in stock returns (e.g., Mabrouk and Aloui,2010; and Tan and Khan, 2010), exchange rates (e.g., Nouira et al., 2004; and Beine et al., 2002), commodities (Choi and Hammoudeh, 2009; and Kyrtsou et al., 2004), and exchange-traded funds (ETFs) (e.g., Rompotis, 2011; and Yang et al., 2010). However, there are no extensive literature has been written to characterize the predictability and asymmetric volatility of real estate ETFs.

Long-term investors have always been attracted to real estate investments because of its stable flow of income. Real estate assets also have low correlation to equity and fixed-income markets, particularly before the sub-prime mortgage crisis, when markets experienced the dot-com bubble and drastic decline in Treasury bill rates. Real estate investment trust (REIT) is one of the solutions in investing in real estate without actually having the real asset. A REIT is a company that owns and operates income-producing real estate or real estate-related assets. The income-producing real estate assets owned by a REIT may include office buildings, apartments, hotels, resorts, shopping malls, self-storage facilities, warehouses, and mortgages or loans.

Most investors see that investment in REITs requires a long-term horizon to maximize returns, however, traders wanting to own real estate and REITs as short-term investments can directly invest in exchange-traded funds (ETFs) that track indices based on real estate assets. Real estate ETFs are basket of investments in businesses that own and manage portfolios of residential and commercial real estate assets, which are either REIT securities or related derivatives. The website ETFdb.com, as of May 6, 2014, lists 29 actively-traded REIT ETFs with a combined market capitalization of $43.40 billion, and with the revival of interest in real estate, this number is expected to grow. The reason why investors are attracted to real estate ETFs is because they can only allot a minimum level of their holdings on the REIT indices portfolio and can already benefit from a broad coverage, where it would be very expensive if a direct investment was made. Investing in REIT ETFs offers a more cost-effective means of trading real estate assets and also provides greater exposure to both local and international real estate investments. However, one big disadvantage of holding REIT ETFs is shares that investors own can also drop when property values fall.

The research is motivated by the recent surge in the application of fractionally-integrated long-memory models in financial time-series and its comparison to short-memory models. This research is also motivated in adding to the limited literature of real estate ETFs, particularly determining the differences in the characteristics of two broad real estate ETFs categories, namely, Global Real Estate ETFs and US Real Estate ETFs traded in US major stock exchanges. This study particular compares short-memory models namely, autoregressive moving average (ARMA), asymmetric power autoregressive conditional heteroskedasticity (APARCH), and exponential generalized autoregressive conditional heteroskedasticity (EGARCH); against their fractionally-integrated long-memory model counterparts, ARFIMA, FIAPARCH, and FIEGARCH. The autocorrelation function of short-memory models are said to decay at an exponential rate, while those of long-memory models decay at a hyperbolic rate. This means that fractionally-integrated models are better in determining positive dependence between distant observations, and improves the modeling of time-series data (e.g., Ruzgar and Kale, 2007; and Goudarzi, 2010). Tsay (2000) even argues that some time-series data (i.e., real interest rates) do not have a unit root, and are fractionally-integrated.

This paper contributes to the literature by comparing two combinations of short-memory models, a) ARMA-APARCH, and b) ARMA-EGARCH; and two combinations of long-memory models, c) ARFIMA-FIAPARCH, and d) ARFIMA-FIEGARCH in examining long-term positive dependence, asymmetry and leverage effects in the returns and volatility of real estate ETFs. In relation with the motivation and contributions, this research differs from the previous studies through these four main objectives:

a) identify the presence of the volatility clustering, leverage effects and volatility asymmetry phenomena in the time-series of US and Global REIT ETFs;
b) determine which type of models (i.e., short- and long-memory models) are better to characterize future values using lagged returns to determine each ETF sub-sample;
c) find out positive long-term dependence in the time-series of ETFs, and examine the dual long-memory process in their returns and volatilities;
d) determine differences in the characteristics of US and Global Real Estate ETFs with regards to their short-, intermediate-, and long-memory processes;

To the best of our knowledge, there is no study that has been done comparing these two groups of real estate ETFs satisfying these objectives. There are a number of studies (e.g., Pong et al., 2004; and Tansuchat et al., 2009) comparing short- and long-memory models, however, no research has yet attempted to use the models that we are suggesting and the way we divided the data into two categories: US real estate ETFs are those that track US REIT indices; and global real estate ETFs are those that track international REIT indices. This paper attempts to find out if the heightened volatility caused by the recent subprime mortgage crisis will affect the characteristics of real estate ETFs in the US more than its international counterparts.

This research discussed on this section the background of return and volatility characteristics; introduction of real estate ETFs and its two sub-categories; and the motivation, contributions and objectives. Section 2 presents the literature review; Section 3 explains the data and methodology based on ARMA-APARCH, ARMA-EGARCH, ARFIMA-APARCH, and ARFIMA-FIEGARCH models; Section 4 explains the empirical results; and Section 5 presents the discussions and limitations of the paper.

2. LITERATURE REVIEW

This section provides an overview of papers regarding the utilization and comparison of short- and long-memory models in different investment instruments including real estate ETFs. A number of studies compared the performance of short-memory models against their fractionally-integrated counterparts. Using stock markets data, Ruzgar and Kale (2007) estimated and forecasted the volatility of was Istanbul Stock Exchange 100 Index log returns by analyzing the performance of 11 ARCH-type models, including fractionally-integrated models. The results found that fractionally-integrated asymmetric models outperform the short-memory models. Goudarzi (2010) used fractionally-integrated GARCH models using the BSE500 stock index to examine the presence of long-memory properties. The findings showed that the FIEGARCH is the best fitting model and outperforms other ARCH-type models in modeling volatility in the Indian stock market.

The comparison also was applied in the derivatives and exchange rate markets, Tansuchat et al. (2009) investigated the long-memory volatility model for 16 agricultural commodity futures returns. The results showed that the long-memory models, like FIGARCH and FIEGARCH are considerably better than traditional conditional volatility models, like GARCH and EGARCH. Pong et al. (2004) forecasted realized volatility of exchange rates using ARMA, ARFIMA and GARCH models. The study found that out of the twenty-four datasets, ARFIMA has the least error in eight cases, ARMA fits six cases and the GARCH model is only best for one dataset. In a related study, Harris et al. (2011) utilized the cyclical volatility model to examine the long-run dynamics of the intraday range of the GBP/USD, JPY/USD and CHF/USD exchange rates and then compare the forecasts of the cyclical volatility model with those of the range-based EGARCH and FIEGARCH models. The findings showed that out-of-sample forecasts generated by the cyclical volatility model are able to explain a substantial fraction of the variation in actual volatility.

The literature mentioned above shaped the contributions and objectives of this research, and will attempt to fill the gap by characterizing the long-memory and asymmetric volatility properties of real estate ETFs, which also compares short- and long-memory models. Although a good number of studies regarding other types of ETFs have been made, particularly the short-memory ARMA-GARCH-types, this research noticed that the performance of fractionally-integrated models have yet to be applied to real estate ETFs.

3. DATA AND METHODOLOGIES

The data of this research was extracted from Yahoo! Finance website utilizing daily closing prices of the twenty (out of the thirty-seven currently listed) Real Estate ETFs trading in the US starting from their different inception dates to November 1, 2013.We divided the real estate ETFs into two categories, namely 1) US Real Estate ETFs or those that tracks US REIT indices; and 2) Global Real Estate ETFs or those that tracks international REIT indices. The study chose fifteen actively-traded Global and US real estate ETFs from the category to ensure a better time-series data with the absence of zero trading volumes, which negatively affects their volatility and the modeling of the financial time-series.

The series of returns were computed as $y_t = 100(\log p_t - \log p_{t-1})$, where p_t represents the price at time t. The financial time-series data were modeled by ARMA-EGARCH, ARMA-APARCH, ARFIMA-FIEGARCH and ARFIMA-FIAPARCH processes are explained below.

3.1 Short- and long- memory processes in the Conditional Mean

3.1.1 The ARMA Model

Box and Jenkins (1970) introduced time-series models capture short-range correlations where the predictors are previous observations represented by the AR function, and previous residual errors modeled by the MA process. The basic ARMA (*r, s*) model can be represented as:

$$y_t = \phi_1 y_{t-1} + \ldots + \phi_r y_{t-r} + \varepsilon_t + \phi_1 \varepsilon_{t-1} + \ldots + \theta_s \varepsilon_{t-s} \tag{1}$$

and the general ARMA (*r*,*s*) can be specified as:

$$y_t = \phi_0 + \sum_{i=1}^{r} \phi_i y_{t-1} + \varepsilon_t + \sum_{j=1}^{s} \phi_j \varepsilon_{j-1} \tag{2}$$

where *r* represents the order of the AR(*r*) part, ϕ_i its parameters, *s* the order of the MA(*s*) part, θ_j its parameters and ε_t normally and identically distributed noise. ARMA models are flexible and able to describe the serial dependencies of time-series in terms of the number of parameters of the AR and MA components.

3.1.2 The ARFIMA Model

A decade after the introduction of the ARMA model, a phenomenon was observed in the time-series where fluctuations over time often display long-range correlations. To capture these long-term dependencies, Granger and Joyeux (1980) and Hosking (1981) introduce the ARFIMA model, which allows the difference parameter to be a non-integer and consider the fractionally integrated process $I(d)$ in the conditional mean. The polynominals representing the ARFIMA (*r*,*d*,*s*) model can be represented as:

$$\phi(L)(1-L)^d (yt - \mu) = \theta(L)\varepsilon_t \tag{3}$$

The fractional differencing operator $(1-L)_d$ is a notation for the following infinite polynominal:

$$(1-L)^d = \sum_{i=0}^{\infty} \frac{\Gamma(i-d)}{\Gamma(i+1)\Gamma(-d)} L^i = \sum_{i=0}^{\infty} \pi_i(d) L^i \tag{4}$$

where $\pi_i(z) \equiv \Gamma(i-z)/\Gamma(i+1)\Gamma(-z)$ and $\Gamma(.)$ is the Standard gamma function. When the difference parameter of the ARFIMA model is $-0.5 < d < 0.5$, the process is stationary where the effect of shocks to ε_t decays at a gradual rate to zero. If *d = 0*, the process indicates short memory and the effect of shocks decays geometrically. When *d = 1*, there is a unit root process. For *0 < d < 0.5*, the process represents a long-memory or positive dependence among distant observations is present. If *-0.5 < d < 0* there is the presence of intermediate memory or anti-persistence. When $d \geq 0.5$, the process is non-stationary, while $d \leq -0.5$ is a stationary, but noninvertible process, which means that the data time-series cannot be represented by any AR model.

3.2. Short and Long-memory Models in the Conditional Variance

3.2.1 The EGARCH Model

The EGARCH model was suggested by Nelson (1991) where the conditional variance may be written as follows:

$$\ln\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q}\alpha_i s(z_{t-1}) + \sum_{j=1}^{p}\beta_j \ln(\sigma_{t-j}^2) \tag{5}$$

where $z_t = \varepsilon_t / \sigma_t$ represents the normalized residuals series. The function *s*(.) can be specified as:

$$s(z_t) = \delta_1 z_t + \delta_2\{|z_t| - E(|z_t|)\} \tag{6}$$

where δ_1 and z_t adds the effect of the sign of ε_t whereas $\delta_2\{|z_t| - E(|z_t|)\}$ adds its magnitude effect. For the normal distribution, $E(|z_t|) = \sqrt{\frac{2}{\pi}}$, the asymmetric nature of the returns can be illustrated by the nonzero value of the coefficient δ_1, while a positive value of δ_1 specifies a leverage effect. Furthermore, external unexpected shocks will have a stronger influence on the predicted volatility than TARCH or GJR.

3.2.2 The APARCH Model

The APARCH model of Ding et al. (1993) includes a power term that acts to emphasize the periods of relative tranquility and volatility by magnifying the outliers in the time-series. The APARCH model estimates the optimal power term rather than imposing a structure on the data. The APARCH (*p,q*) model can be written as:

$$\sigma_t^\delta = \alpha_0 + \sum_{i=1}^{q}\alpha_i(|\varepsilon_{t-i}| - \gamma_i\varepsilon_{t-i})^\delta + \sum_{j=1}^{p}\beta_j\sigma_{t-1}^\delta \tag{7}$$

where $\alpha_0 > 0$, $\delta \geq 0$, $\beta_j \geq 0$, $\alpha_i \geq 0$ and $-1 < \gamma_i < 1$.

The APARCH model provides the flexibility of a varying exponent δ with the asymmetry coefficient γ_i to account the leverage effect. The APARCH model can be reduced to the ARCH model when δ = 2, $\gamma_i = 0$ (i = 1,. . . ,p) and $\beta_j = 0$ (j = 1,. . . ,p); GARCH model when δ = 2 and $\gamma_i = 0$ (i = 1,. . . ,p); and the GJR when δ = 2.

3.2.3 The FIEGARCH and FIAPARCH Models

The FIEGARCH of Bollerslev and Mikkelsen (1996) and the FIAPARCH of Tse(1998) are another extension of the fractionally-integrated models. Similar to its short-memory counterparts EGARCH and APARCH processes, they can be extended to account for long-memory through the factorization of the autoregressive polynomial[1 – $\beta(L)$] = $\phi(L)(1-L)^d$ where all the roots of $\phi(z)$ = 0 lie outside the unit circle.

The FIEGARCH (*p, d, q*) is can be expressed as follows:

$$\ln(\sigma_t^2) = \omega + \phi(L)^{-1}(1-L)^{-d}[1+\alpha(L)]s(z_{t-1}) \tag{8}$$

And the FIAPARCH (*p, d, q*) model can be specified as:

$$\sigma_t^\delta = \omega + \{1-[1-\beta(L)]^{-1}\phi(L)(1-L)^d\}(|\varepsilon_t| - \gamma\varepsilon_t)^\delta \tag{9}$$

4. EMPIRICAL RESULTS

Table 1 describes the average returns of real estate ETFs. Most of the average returns of Global Real Estate ETFs are positive with the exception of RWX and VNQI, whereas US Real Estate ETFs have only 4 positive average ETFs, namely FNIO, REM, MORT and FTY. For the whole sample, US real estate ETFs have both the highest and lowest average returns. PSR ETF posted the highest return with 0.038, while REM ETF has lowest average return of -0.038. US real estate ETFs also posted a slightly higher average standard deviation of 0.899, while global real estate ETFs posted 0.825. We posit that the recent subprime mortgage crisis greatly affected the local volatility of the US markets more compared to global real estate as a whole. Most of selected ETFs are negatively skewed, all data samples have positive kurtosis, and the significant Jarque-Bera statistic for residual normality indicated that real estate ETF returns are under a non-normal distribution assumption.

TABLE 1: THE SAMPLE SIZE AND PERIOD OF ETFs RETURNS

US Real Estate ETFs ETFs	**Start of Data**	**Daily Obs.**	**Mean**	**Std. Dev.**	**Skew.**	**Kurt.**	**J-Bera**
Vanguard REIT Index ETF (VNQ)	Apr 10, 2004	2288	0.006	1.022	-0.244	14.465	15254.30***
iShares Indl/Office Rel Est Capped ETF (FNIO)	May 9, 2007	1633	-0.012	1.186	-0.153	17.086	13507.01***
PowerShares KBW Prem Yield Equity REIT (KBWY)	Dec 14, 2010	726	0.014	0.536	-0.903	10.318	1718.61***
Schwab US REIT ETF (SCHH)	Jan 14, 2011	705	0.015	0.581	-0.251	10.547	1680.44***
iShares Residential Real Estate Capped ETF (REZ)	May 7, 2007	1637	0.001	1.118	0.022	13.022	6851.11***
PowerShares Active U.S. Real Estate (PSR)	Nov 24, 2008	1244	0.038	0.906	-0.012	18.097	11813.37***
iShares Real Estate 50 ETF (FTY)	May 7, 2007	1637	-0.005	1.118	0.093	14.532	9073.29***
Average value			*0.057*	*6.467*			
Global Real Estate ETFs ETFs	**Start of Data**	**Daily Obs.**	**Mean**	**Std. Dev.**	**Skew.**	**Kurt.**	**J-Bera**
Vanguard Global ex-US Real Estate ETF (VNQI)	Nov 2, 2010	756	0.008	0.556	-0.468	7.308	612.29***
SPDR Dow Jones Global Real Estate (RWO)	May 23, 2008	1372	-0.004	0.903	-0.408	8.903	2030.19***
iShares International Developed Real Estate ETF (IFGL)	Dec 28, 2007	1473	-0.010	0.813	-0.448	9.237	2436.75***
iShares International Developed Property (WPS)	Aug 08, 2007	1572	-0.008	0.800	-0.314	9.346	2663.69***
Cohen & Steers Global Realty Majors ETF (GRI)	May 23, 2008	1372	-0.005	0.858	-0.176	12.994	5716.33***
Guggenheim China Real Estate ETF (TAO)	Dec 18, 2007	1479	-0.003	1.000	0.228	7.936	1514.17***
iShares Asia Developed Real Estate ETF (IFAS)	Jan 8, 2008	1467	-0.008	0.830	-0.416	8.779	2083.78***
FTSE EPRA/NAREIT Europe Index Fund (IFEU)	Dec 28, 2007	1473	-0.001	1.138	1.416	98.430	559430.8***
Average value			*-0.031*	*6.898*			

Note: *,**, and *** are significant 10, 5, and 1% levels respectively.

Table 2 illustrates filtered time-series data using the ARMA and GARCH filters. The Augmented Dickey-Fuller test examined the stationarity of the data, and the minimum value of the Akaike Information Criterion identified the orders of the models. All ETF return samples have no serial correlation, based on the results of the Lagrange Multiplier (LM) test. This paper used the ARCH-LM process to identify the ARCH effect, and showed that GARCH models can be applied in the sample. The filtering also determined thatall the real estate ETF samples are free from heteroscedasticity by having insignificant values of ARCH-LM.

TABLE 2: SUMMARY STATISTICS OF UNIT ROOT, LM AND ARMA-LM TESTS FOR ETF RETURNS

US REIT ETFs	**ADF**	**ARMA**	**AIC**	**LM**	**ARCH-LM**	**GARCH**	**AIC**	**ARCH-LM**
VNQ	-24.435*** (0.000)	(0,1)	2.483	0.439 (0.802)	305.102*** (0.000)	(1,2)	1.955	0.211 (0.899)
FNIO	-21.497*** (0.000)	(1,2)	3.153	2.403 (0.360)	180.768*** (0.000)	(1,1)	2.349	0.387 (0.823)
KBWY	-25.823*** (0.000)	(0,0)	1.592	1.942 (0.378)	53.405*** (0.000)	(2,2)	2.288	0.088 (0.956)
SCHH	-13.478*** (0.000)	(1,1)	1.729	0.483 (0.785)	107.994*** (0.000)	(1,2)	1.320	6.766 (0.148)
REZ	-21.356*** (0.000)	(2,1)	3.025	5.662 (0.225)	230.406*** (0.000)	(2,2)	2.175	0.995 (0.608)
PSR	-23.425*** (0.000)	(2,2)	2.618	4.352 (0.113)	19.305*** (0.000)	(2,2)	1.941	1.1087 (0.580)
FTY	-33.173*** (0.000)	(2,2)	3.034	1.754 (0.415)	123.728*** (0.000)	(1,1)	2.169	0.807 (0.667)
Global REIT ETFs	**ADF**	**ARMA**	**AIC**	**LM**	**ARCH-LM**	**GARCH**	**AIC**	**ARCH-LM**
VNQI	-13.652*** (0.000)	(1,1)	1.645	1.317 (0.517)	102.971*** (0.000)	(2,2)	1.464	3.323 (0.189)
RWO	-40.403*** (0.000)	(0,1)	2.628	1.014 (0.602)	139.653*** (0.000)	(2,2)	1.967	1.546 (0.461)
IFGL	-41.989*** (0.000)	(2,2)	2.413	5.858 (0.118)	156.227*** (0.000)	(2,2)	1.971	2.208 (0.331)
WPS	-22.160*** (0.000)	(2,2)	2.382	4.916 (0.178)	179.756*** (0.000)	(2,2)	1.942	4.902 (0.179)
GRI	-38.790*** (0.000)	(0,1)	2.532	0.138 (0.933)	134.259*** (0.000)	(1,2)	1.977	0.113 (0.945)
TAO	-29.170*** (0.000)	(1,1)	2.838	2.154 (0.340)	192.439*** (0.000)	(1,2)	2.412	10.812 (0.147)
IFAS	-21.447*** (0.000)	(2,2)	2.449	3.048 (0.217)	177.848*** (0.000)	(2,2)	2.096	15.741 (0.107)
IFEU	-48.612*** (0.000)	(1,1)	3.042	1.199 (0.549)	181.256*** (0.000)	(1,2)	2.452	11.895 (0.104)

Note: *,**, and *** are significant 10, 5, and 1% levels respectively.

4.1 Lagged innovations, volatility clustering and leverage effects

Tables 3 and4compare the findings of ARMA-EGARCH and ARFIMA-FIEGARCH in determining the effects of lagged returns and volatilities, and the presence of leverage effects. Majority of the estimated values show that significant lagged conditional variance values of a_n and ψ_n are relatively greater than those of significant lagged mean returns of a_n and θ_n. These outcomes suggest that both the short and long memory models agree on the existence of volatility clustering phenomenon having stronger influence on current innovations. The results are also consistent with the findings of Fama (1965), Engle (1982) and Koutmos et al. (1994) in their study of volatility clustering. ARMA-EGARCH and ARFIMA-FIEGARCH models also both settle on the leverageeffects phenomenon withthesignificantnegativevaluesofthe delta (δ) parameter. The short memory model identifies leverage effects for most REIT ETFs, except for PSR US REIT and IFAS Global REIT ETFs. On one hand, the long memory model does not determine leverage effects in two US REIT ETFs, namely, FNIO and SCHH; and three Global REIT ETFs, namely GRI, TAO and IFEU, which all have insignificant values. The study concludes that REIT ETFs whether local or overseas are also very typical investments prone to losses in times of greater uncertainty brought about by increased volatility.

TABLE 3: LAGGED INNOVATIONS AND LEVERAGE EFFECTS IN REIT ETFS USING ARMA-EGARCH MODELS

US ETFs	Model	Mean Equation					Conditional Variance Equation					
		α_0	α_1	α_2	θ_1	θ_2	a_0	a_1	a_2	ψ_1	ψ_2	δ
VNQ	ARMA(0,1)-EGARCH(2,2)	0.022 (0.503)			-0.026 (0.327)		-0.813* (0.051)	0.585*** (0.000)	-0.306** (0.032)	-0.002 (0.712)	0.983*** (0.000)	-0.078*** (0.004)
FNIO	ARMA(1,2)-EGARCH(2,2)	0.021 (0.115)	-0.894*** (0.000)		0.849*** (0.000)	-0.055** (0.036)	-0.273	1.133** (0.036)	0.393 (0.548)	0.010 (0.336)	0.972*** (0.000)	-0.058* (0.080)
KBWY	ARMA(0,0)-EGARCH(2,2)	0.017** (0.025)					-1.346*** (0.000)	1.004** (0.012)	-0.688*** (0.001)	0.123 (0.161)	0.839*** (0.000)	-0.122*** (0.002)
SCHH	ARMA(1,1)-EGARCH(2,1)	0.007 (0.671)	0.165 (0.344)		-0.162 (0.373)		-1.337*** (0.000)	1.144** (0.018)		0.104** (0.019)	0.843*** (0.000)	-0.073*** (0.008)
REZ	ARMA(2,1)-EGARCH(1,0)	0.017 (0.202)	-1.040*** (0.000)	-0.085*** (0.001)	0.958*** (0.000)		-0.064 (0.872)			0.991*** (0.000)		-0.054*** (0.001)
PSR	ARMA(2,2)-EGARCH(2,2)	0.026*** (0.003)	1.002 (0.306)	-0.092 (0.916)	-1.058 (0.280)	0.106 (0.909)	3.101 (0.211)	1.400 (0.121)	-0.742 (0.414)	0.204 (0.736)	0.793 (0.187)	-0.033 (0.308)
FTY	ARMA(2,2)-EGARCH(1,0)	0.018** (0.027)	1.104*** (0.004)	-0.147 (0.679)	-1.161*** (0.002)	0.185 (0.614)	-0.057 (0.901)			0.991*** (0.000)		-0.049*** (0.005)
Global ETFs	**Model**	**Mean Equation**					**Conditional Variance Equation**					
		α_0	α_1	α_2	θ_1	θ_2	a_0	a_1	a_2	ψ_1	ψ_2	δ
VNQI	ARMA(1,1)-EGARCH(2,1)	0.005 (0.758)	0.582*** (0.000)		-0.638*** (0.000)		-1.309*** (0.000)	1.784** (0.012)		0.074 (0.228)	0.830*** (0.000)	-0.092** (0.012)
RWO	ARMA(0,1)-EGARCH(2,2)	0.009 (0.532)			-0.075*** (0.002)		-0.661 (0.126)	1.172* (0.079)	-0.759* (0.091)	0.451 (0.229)	0.534 (0.151)	-0.089** (0.037)
IFGL	ARMA(2,2)-EGARCH(2,2)	-0.000 (0.984)	-0.206 (0.644)	0.205 (0.609)	0.159 (0.718)	-0.176 (0.648)	-0.745*** (0.003)	0.971** (0.023)	-0.506** (0.036)	0.098*** (0.004)	0.880*** (0.000)	-0.120** (0.010)
WPS	ARMA(2,2)-EGARCH(2,1)	-0.017 (0.430)	0.455*** (0.001)	0.486*** (0.001)	-0.492*** (0.001)	-0.429*** (0.003)	-0.690*** (0.003)	1.948*** (0.002)		0.112*** (0.006)	0.858*** (0.000)	-0.075*** (0.002)
GRI	ARMA(0,1)-EGARCH(1,0)	-0.006 (0.435)			-0.043 (0.147)		-0.062 (0.882)			0.988*** (0.000)		-0.069*** (0.000)
TAO	ARMA(1,1)-EGARCH(2,2)	-0.016 (0.335)	0.608* (0.073)		-0.576 (0.127)		-0.339 (0.317)	-0.539 (0.277)	-0.415 (0.382)	1.919*** (0.000)	-0.919*** (0.000)	-0.088*** (0.004)
IFAS	ARMA(2,2)-EGARCH(2,1)	-0.006 (0.731)	-0.599*** (0.000)	-0.882*** (0.000)	0.590*** (0.000)	0.881*** (0.000)	-0.521** (0.043)	1.523 (0.363)		0.168 (0.871)	0.809 (0.432)	-0.053 (0.419)
IFEU	ARMA(1,2)-EGARCH(1,1)	0.006 (0.723)	-0.529 (0.488)		0.450 (0.556)	0.004 (0.971)	4.914 (0.602)	-0.768*** (0.000)		0.998*** (0.000)		-0.178* (0.084)

Note: *, ** and *** are significance at 10, 5 and 1% levels, respectively; p-values are in parentheses.

TABLE 4: LAGGED INNOVATIONS AND LEVERAGE EFFECTS IN REIT ETFS USING ARFIMA-FIEGARCH MODELS

US ETFs	**Model**	**Mean Equation**					**Conditional Variance Equation**					
		α_0	α_1	α_2	θ_1	θ_2	a_0	a_1	a_2	ψ_1	ψ_2	δ
VNQ	ARFIMA(0,1)-FIEGARCH(2,2)	0.023*** (0.000)			0.062* (0.083)		-1.095*** (0.008)	0.256 (0.104)	-0.590*** (0.001)	-0.120 (0.181)	0.866*** (0.000)	-0.078*** (0.005)
FNIO	ARFIMA(2,2)-FIEGARCH(1,1)	0.018 (0.508)	-0.355 (0.566)	0.540 (0.222)	0.427 (0.252)	-0.490* (0.061)	-0.318 (0.628)	-0.501 (0.492)		0.948*** (0.000)		-0.074 (0.212)
KBWY	ARFIMA(2,0)-FIEGARCH(2,2)	0.016* (0.055)	0.047** (0.044)	0.006 (0.797)			-1.438*** (0.000)	1.347** (0.025)	-0.305 (0.5458)	0.135 (0.119)	0.839*** (0.000)	-0.122*** (0.004)
SCHH	ARFIMA(2,2)-FIEGARCH(1,2)	0.014*** (0.000)	1.783*** (0.000)	-0.788*** (0.000)	-0.690*** (0.000)	-0.060 (0.244)	-1.315** (0.021)	0.694 (0.385)	-0.244 (0.542)	-0.147 (0.758)		-0.040 (0.338)
REZ	ARFIMA(1,2)-FIEGARCH(2,1)	0.017*** (0.001)	-0.175*** (0.008)		-0.309* (0.063)	0.062** (0.041)	0.563 (0.469)	-0.776*** (0.002)		1.104 (0.166)	-0.157 (0.823)	-0.058** (0.024)
PSR	ARFIMA(1,1)-FIEGARCH(2,2)	0.025*** (0.005)	-0.930*** (0.000)		0.919*** (0.000)		2.187*** (0.000)	-1.259*** (0.000)	1.049*** (0.000)	1.207*** (0.000)	-0.970*** (0.000)	-0.073* (0.037)
FTY	ARFIMA(2,2)-FIEGARCH(1,0)	0.014** (0.027)	1.170** (0.018)	-0.525 (0.147)	-1.072** (0.041)	0.485 (0.150)	-0.194 (0.675)			0.756*** (0.000)		-0.041** (0.012)
Global ETFs	**Model**	**Mean Equation**					**Conditional Variance Equation**					
		α_0	α_1	α_2	θ_1	θ_2	a_0	a_1	a_2	ψ_1	ψ_2	δ
VNQI	ARFIMA(1,2)-FIEGARCH(2,1)	0.014 (0.192)	0.315 (0.530)		-0.173 (0.737)	0.053 (0.673)	-1.480*** (0.000)	1.696** (0.034)		-0.178 (0.653)	0.628* (0.055)	-0.106* (0.065)
RWO	ARFIMA(1,1)-FIEGARCH(1,1)	0.020*** (0.005)	-0.700*** (0.000)		0.668*** (0.000)		-0.761 (0.115)	1.552*** (0.005)		-0.609** (0.026)		-0.087** (0.047)
IFGL	ARFIMA(2,2)-FIEGARCH(2,2)	-0.004 (0.746)	-0.252 (0.505)	0.222 (0.530)	0.237 (0.582)	-0.182 (0.615)	-0.695** (0.030)	0.693** (0.030)	-0.899*** (0.000)	-0.019 (0.731)	0.793*** (0.000)	-0.133*** (0.003)
WPS	ARFIMA(2,2)-FIEGARCH(2,2)	0.000 (0.997)	0.049 (0.930)	0.070 (0.787)	-0.063 (0.910)	-0.030 (0.912)	-0.858*** (0.001)	0.907** (0.035)	-0.817*** (0.001)	-0.045 (0.626)	0.717*** (0.000)	-0.131*** (0.006)
GRI	ARFIMA(1,0)-FIEGARCH(2,1)	0.005 (0.521)	0.065 (0.317)				0.526 (0.367)	-0.707 (0.137)		1.067*** (0.000)	-0.686*** (0.000)	-0.040 (0.124)
TAO	ARFIMA(2,0)-FIEGARCH(1,2)	-0.011 (0.331)	0.079** (0.031)	0.003 (0.858)			-0.129 (0.742)	1.271 (0.462)	-1.503 (0.279)	0.891*** (0.000)		-0.053 (0.109)
IFAS	ARFIMA(2,2)-FIEGARCH(0,1)	0.004 (0.702)	-0.604*** (0.000)	-0.901*** (0.000)	0.601*** (0.000)	0.901*** (0.000)	-0.499 (0.120)	1.058 (0.200)				-0.080* (0.056)
IFEU	ARFIMA(2,2)-FIEGARCH(2,2)	0.018 (0.141)	-0.052 (0.331)	-0.210*** (0.000)	0.030 (0.433)	0.349*** (0.000)	1.556** (0.029)	2.685 (0.639)	-2.159 (0.605)	0.686*** (0.001)	-0.302* (0.069)	-0.006 (0.788)

Note: *, ** and *** are significance at 10, 5 and 1% levels, respectively; p-values are in parentheses.

4.2 Lagged innovations, volatility clustering and asymmetry

Tables 5 and 6 compare the findings of ARMA-APARCH and ARFIMA-FIAPARCH in determining the effects of lagged returns and volatilities, and the presence of volatility asymmetry. Majority of the estimated values show that significant lagged conditional variance values of a_n and ψ_n are relatively greater than those of significant lagged mean returns of a_n and θ_n. These outcomes suggest that both the short and long memory models also agree on the existence of volatility clustering phenomenon having stronger influence on current innovations.Aside from the earlier studies mentioned above, the findings are also consistent with the recent studies of Chen and Huang (2010), Chen and Diaz (2012a) and Chen and Diaz (2012b) when they found volatility clustering in the returns and volatilities of equity, faith and leveraged ETFs, respectively. ARMA-APARCH and ARFIMA-FIAPARCH models also both settle on the presence of asymmetric volatilitywiththesignificantpositive valuesofthe gamma (γ) coefficient. The short memory model identifies asymmetric volatility for all US and Global REIT ETFs. On one hand, the long memory model does not determine asymmetric volatility in two US REIT ETFs, namely, SCHH and PSR; and one Global REIT ETFs, namely IFEU, which all have insignificant values. The study concludes that REIT ETFs are not immune to negative shocks, because they havebiggerimpactonstockreturns andvolatilitiesthanpositivenewsofthesame magnitude. Bekaert and Wu (2000) earlier explained that negative shocks increases conditional variances in the financial markets substantially because of the high volatility feedback mechanism. This claim was particularly observed by Tan and Khan (2010) in their study of Malaysian stock markets during the subprime mortgage crisis.

TABLE 5: LAGGED INNOVATIONS AND VOLATILITY ASYMMETRY IN REIT ETFS USING ARMA-APARCH MODELS

US ETFs	**Model**	**Mean Equation**					**Conditional Variance Equation**					
		α_0	α_1	α_2	θ_1	θ_2	a_0	a_1	a_2	ψ_1	ψ_2	γ
VNQ	ARMA(0,1)-APARCH(1,2)	0.020** (0.041)			-0.029 (0.140)		-0.006*** (0.005)	0.140*** (0.000)	-0.047 (0.166)	0.917 (0.000)		1.218*** (0.000)
FNIO	ARMA(1,2)-APARCH(2,2)	0.010 (0.498)	-0.907*** (0.000)		0.857*** (0.000)	-0.061** (0.026)	0.013*** (0.005)	0.088*** (0.000)	0.060*** (0.000)	-0.048** (0.011)	0.915*** (0.000)	1.107*** (0.000)
KBWY	ARMA(0,0)-APARCH(1,2)	0.021 (0.178)					0.003 (0.129)	0.112* (0.053)	-0.107 (0.126)	0.954*** (0.000)		2.103*** (0.000)
SCHH	ARMA(1,1)-APARCH(1,1)	0.012 (0.469)	0.171 (0.372)		-0.169 (0.344)		0.008** (0.048)	0.108** (0.010)		0.873*** (0.000)		1.705*** (0.000)
REZ	ARMA(2,1)-APARCH(2,1)	0.019 (0.124)	-0.443 (0.220)	-0.022 (0.501)	0.359 (0.320)		0.005* (0.057)	0.148*** (0.000)		0.302** (0.311)	0.558** (0.040)	1.725*** (0.000)
PSR	ARMA(2,2)-APARCH(1,1)	0.029*** (0.001)	0.053 (0.678)	0.848*** (0.000)	-0.079 (0.540)	-0.861*** (0.000)	0.001 (0.308)	0.021 (0.201)		0.924*** (0.000)		3.876*** (0.001)
FTY	ARMA(2,2)-APARCH(1,1)	0.015 (0.171)	-0.000 (0.999)	0.672*** (0.008)	-0.047 (0.866)	-0.708*** (0.003)	0.005** (0.021)	0.095*** (0.000)		0.916*** (0.000)		1.293*** (0.000)
Global ETFs	**Model**	**Mean Equation**					**Conditional Variance Equation**					
		α_0	α_1	α_2	θ_1	θ_2	a_0	a_1	a_2	ψ_1	ψ_2	γ
VNQI	ARMA(1,1)-APARCH(1,1)	0.002 (0.899)	0.532*** (0.000)		-0.574*** (0.000)		0.016** (0.038)	0.075** (0.018)		0.870*** (0.000)		1.629*** (0.008)
RWO	ARMA(0,1)-APARCH(2,2)	0.005 (0.704)			-0.066** (0.018)		0.011** (0.013)	0.077*** (0.003)	0.075 (0.102)	0.066 (0.107)	0.769*** (0.000)	1.505*** (0.000)
IFGL	ARMA(2,2)-APARCH(1,1)	-0.006 (0.700)	-0.269 (0.510)	0.162 (0.639)	0.233 (0.573)	-0.135 (0.695)	0.008** (0.013)	0.046** (0.047)		0.931*** (0.000)		1.564*** (0.000)
WPS	ARMA(2,2)-APARCH(1,2)	-0.014 (0.493)	0.465** (0.013)	0.449* (0.083)	-0.497*** (0.009)	-0.405 (0.115)	0.011*** (0.006)	0.029* (0.092)	0.050 (0.129)	0.904*** (0.000)		1.420*** (0.000)
GRI	ARMA(0,1)-APARCH(1,2)	-0.008 (0.552)			-0.033 (0.359)		0.010 (0.112)	0.051* (0.054)	0.041 (0.369)	0.912*** (0.000)		1.171*** (0.004)
TAO	ARMA(1,1)-APARCH(1,2)	-0.005 (0.794)	-0.087 (0.777)		0.140 (0.645)		0.008** (0.030)	0.010 (0.439)	0.043* (0.080)	0.909*** (0.000)		2.243*** (0.001)
IFAS	ARMA(2,2)-APARCH(1,1)	-0.007 (0.664)	-0.603*** (0.000)	-0.890*** (0.000)	0.595*** (0.000)	0.885*** (0.000)	0.007** (0.025)	0.053*** (0.009)		0.938*** (0.000)		1.468*** (0.002)
IFEU	ARMA(1,2)-APARCH(1,2)	0.006 (0.741)	-0.986*** (0.000)		0.927*** (0.000)	-0.056* (0.073)	0.003*** (0.001)	0.227** (0.016)	-0.220** (0.019)	0.976*** (0.000)		2.337*** (0.000)

Note: *, ** and *** are significance at 10, 5 and 1% levels, respectively; p-values are in parentheses.

TABLE 6: LAGGED INNOVATIONS AND VOLATILITY ASYMMETRY IN REIT ETFS USING ARFIMA-FIAPARCH MODELS

US ETFs	**Model**	**Mean Equation**					**Conditional Variance Equation**					
		α_0	α_1	α_2	θ_1	θ_2	a_0	a_1	a_2	ψ_1	ψ_2	γ
VNQ	ARFIMA(0,1)-FIAPARCH(1,1)	0.022*** (0.001)			0.051 (0.162)		0.011** (0.015)	0.185*** (0.004)		0.797*** (0.000)		0.256*** (0.004)
FNIO	ARFIMA(2,2)-FIAPARCH(2,2)	0.014 (0.193)	0.249*** (0.000)	0.014 (0.193)	-0.252*** (0.000)	0.980*** (0.000)	0.027** (0.030)	-0.812*** (0.000)	0.146 (0.151)	-0.184* (0.096)	0.770*** (0.000)	0.456*** 0.009
KBWY	ARFIMA(2,0)-FIAPARCH(2,1)	0.020 (0.188)	0.090 (0.422)	0.009 (0.889)			0.001 (0.147)	0.073*** (0.000)		1.561*** (0.000)	-0.582*** (0.002)	0.426* (0.064)
SCHH	ARFIMA(2,2)-FIAPARCH(1,2)	0.018* (0.094)	1.163** (0.029)	-0.694*** (0.000)	-1.079** (0.023)	0.681*** (0.000)	0.003 (0.125)	-0.001 (0.926)	0.092 (0.178)	0.942*** (0.000)		0.224 0.121
REZ	ARFIMA(1,2)-FIAPARCH(2,2)	0.016*** (0.001)	0.404* (0.080)		-0.316* (0.088)	0.057* (0.075)	0.010 (0.208)	-0.779*** (0.000)	0.172*** (0.002)	-0.175*** (0.008)	0.775*** (0.000)	0.224** (0.013)
PSR	ARFIMA(1,1)-FIAPARCH(2,1)	0.031*** (0.000)	0.385 (0.239)		-0.307 (0.314)		0.001 (0.379)	-0.882*** (0.000)		0.102 (0.168)	0.795*** (0.000)	0.058 (0.511)
FTY	ARFIMA(2,2)-FIAPARCH(1,1)	0.012** (0.019)	-0.219 (0.430)	0.447*** (0.003)	0.342 (0.162)	-0.356*** (0.003)	0.010 (0.113)	0.151** (0.028)		0.749*** (0.000)		0.349*** (0.009)
Global ETFs	**Model**	**Mean Equation**					**Conditional Variance Equation**					
		α_0	α_1	α_2	θ_1	θ_2	a_0	a_1	a_2	ψ_1	ψ_2	γ
VNQI	ARFIMA(1,2)-FIAPARCH(2,1)	0.011 (0.211)	0.257 (0.540)		-0.138 (0.743)	0.053 (0.555)	0.139 (0.128)	-0.879*** (0.000)		-0.712*** (0.000)	0.108** 0.023	0.882*** (0.001)
RWO	ARFIMA(1,1)-FIAPARCH(2,2)	0.007 (0.053)	-0.682*** (0.000)		0.649*** (0.001)		0.016 (0.215)	-0.156 (0.572)	0.236*** (0.000)	0.318 (0.334)	0.323* (0.054)	0.565** (0.014)
IFGL	ARFIMA(2,2)-FIAPARCH(1,2)	-0.003 (0.821)	-0.175 (0.666)	0.257 (0.391)	0.188 (0.632)	-0.197 (0.490)	0.019* (0.075)	0.377*** (0.000)	0.071* (0.067)	0.744*** (0.000)		0.962*** (0.000)
WPS	ARFIMA(2,2)-FIAPARCH(1,2)	-0.006 (0.649)	-0.009 (0.984)	-0.020 (0.954)	0.004 (0.993)	0.601 (0.867)	0.017** (0.038)	0.346*** (0.002)	0.116*** (0.007)	0.764*** (0.000)		0.848*** (0.003)
GRI	ARFIMA(1,0)-FIAPARCH(1,1)	0.002 (0.857)	0.062 (0.323)				0.026* (0.098)	0.147 (0.162)		0.569*** (0.000)		0.406** (0.049)
TAO	ARFIMA(2,0)-FIAPARCH(1,2)	-0.003 (0.856)	0.081 (0.147)	-0.000 (0.996)			0.005 (0.595)	0.362*** (0.000)	0.108*** (0.006)	0.769*** (0.000)		0.732*** (0.001)
IFAS	ARFIMA(2,2)-FIAPARCH(1,2)	-0.004 (0.795)	-0.603*** (0.000)	-0.898*** (0.000)	0.599*** (0.000)	0.896*** (0.000)	0.015 (0.068)	0.373*** (0.000)	0.123*** (0.001)	0.818*** (0.000)		0.691** (0.028)
IFEU	ARFIMA(2,2)-FIAPARCH(0,2)	0.007 (0.569)	0.581*** (0.000)	-0.850*** (0.001)	-0.553*** (0.000)	0.880*** (0.000)	0.019 (0.465)	0.080 (0.641)	0.057 (0.250)			0.268 (0.104)

Note: *, ** and *** are significance at 10, 5 and 1% levels, respectively; p-values are in parentheses.

The presence of volatility clustering, leverage effects and volatility asymmetry in REIT ETFs are all consistent phenomena. Both short and long memory models provide strong evidence that the effect of the recent subprime mortgage crisis has a global impact, negatively affecting both local and overseas financial instruments tracking real estate related investments. Fund managers and investors in the US are not assured that diversifying their REIT portfolios abroad can provide a solid hedge against local risk and uncertainty.

4.3 Persistence and performance comparisons of short and long memory models

Table 7 shows the comparison between two long-memory models employed. For the US REIT ETFs, the combined ARFIMA-FIEGARCH models, through its ARFIMA specification find intermediate memory process in the returns of VNQ, REZ, PSR and FTY ETFs; also the combined ARFIMA-FIAPARCH models also find anti-persistent properties in the returns of VNQ, FNIO, REZ and FTY ETFs. These findings mean that positive or negative return trends in a particular time are weak among these ETFs, and will more likely change its course in the next trading days. This should serve as a warning sign for investors not to rely too much on their anti-persistence and not to keep investments in the long-run. The combined ARFIMA-FIEGARCH models also identify non-invertible process in returns of SCHH ETF (-1.100 value significant at the 1% level), which means that the sequence cannot be represented by any autoregressive (AR) model, and on a non-mean reversion condition as discussed by Tan and Khan (2010). Furthermore, the combined ARFIMA-FIEGARCH models, through its FIEGARCH specification find long memory processes in the volatilities of VNQ, SCHH, REZ, PSR and FTY ETFs. On the other hand, the combined ARFIMA-FIAPARCH models find long memory processes in the volatilities of most US REIT ETFs, except for KBWY, SCHH and PSR ETFs which all exhibit non-invertible properties. The APARCH model present in the specification is also different from the basic ARCH and GARCH models with the significant delta parameter for all ETF observations. Long memory results mean that their structures have signs of market inefficiency and investors may possibly earn excess returns by properly modeling these US REIT ETFs.

For the Global REIT ETFs, the combined ARFIMA-FIEGARCH models, through its ARFIMA specification find intermediate memory process in the returns of VNQI, RWO, GRI and IFEU ETFs; also the combined ARFIMA-FIAPARCH models find similar anti-persistent property in the returns of only VNQI ETF. Intermediate memory characteristics are also present in the recent findings of Chen and Diaz (2013) and Cevik and Emec (2013) in studying green and non-green ETFs and the Turkish financial market. These results again support indecisive trends among these ETFs that will likely deviate from its course in the next trading periods.

Furthermore, the combined ARFIMA-FIEGARCH models, through its FIEGARCH specification find long memory processes in the volatilities of all Global REIT ETFs, except for VNQI ETF; while the combined ARFIMA-FIAPARCH models find long memory processes in the volatilities of all Global REIT ETFs, except for IFEU ETF. The APARCH model present in the specification is also different from the basic ARCH and GARCH models with the significant delta parameter for all ETF observations. These results mean that their structures have signs of market inefficiency and investors may possibly earn excess returns by properly modeling these Global REIT ETFs.The weak-form EMH (efficiency market hypothesis) of Fama (1970) explains that future prices cannot be predicted by analyzing prices from the past. This also means that excess returns cannot be gained in the long run by using investment strategies based on historical data. Therefore, technical analysis techniques will not be able to consistently produce returns, though some forms of fundamental analysis may still provide excess returns.These findings have already been proven in the literature of financial markets and are consistent with the studies of Kang and Yoon (2007), Korkmaz et al. (2009), and Tan and Khan (2010) in studying the South Korean, Turkish and Malaysian stock markets, respectively.

TABLE 7: LONG-MEMORY ANALYSIS COMPARING ARFIMA-FIEGARCH AND ARFIMA-FIAPARCH

US	ARFIMA-FIEGARCH					ARFIMA-FIAPARCH				
ETFs	**ARFIMA**	**d-coeff.**	**ARCH**	**d-coeff.**	**AIC**	**d-coeff.**	**ARCH**	**d-coeff.**	**delta**	**AIC**
VNQ	(0, 1)	-0.093*** (0.003)	(2,2)	0.535*** (0.000)	1.953	-0.080*** (0.010)	(1,1)	0.749*** (0.000)	1.538*** (0.000)	1.950
FNIO	(2, 2)	-0.112 (0.663)	(1,1)	0.385 (0.448)	2.340	-0.050** (0.034)	(2,2)	0.696*** (0.000)	1.438*** (0.000)	2.333
KBWY	(2, 0)	0.017 (0.291)	(2,2)	-0.145 (0.313)	1.276	-0.034 (0.778)	(2,1)	1.001*** (0.000)	1.380*** (0.000)	1.271
SCHH	(2, 2)	-1.100*** (0.000)	(1,2)	0.762*** (0.000)	1.334	-0.108 (0.102)	(1,2)	1.108*** (0.000)	1.569*** (0.000)	1.324
REZ	(1, 2)	-0.176*** (0.008)	(2,1)	0.513*** (0.004)	2.175	-0.175** (0.019)	(2,2)	0.732*** (0.000)	0.176*** (0.000)	2.168
PSR	(1, 1)	-0.085*** (0.003)	(2,2)	0.754*** (0.000)	1.924	-0.107 (0.104)	(2,1)	1.041*** (0.000)	2.327*** (0.000)	1.990
FTY	(2, 2)	-0.161** (0.017)	(1,0)	0.600*** (0.003)	2.164	-0.176* (0.052)	(1,1)	0.672*** (0.000)	1.534*** (0.000)	2.160
Global	**ARFIMA-FIEGARCH**					**ARFIMA-FIAPARCH**				
ETFs	**ARFIMA**	**d-coeff.**	**ARCH**	**d-coeff.**	**AIC**	**d-coeff.**	**ARCH**	**d-coeff.**	**delta**	**AIC**
VNQI	(1, 2)	-0.196** (0.011)	(2,1)	0.343 (0.338)	1.431	-0.167*** (0.005)	(2,1)	0.232*** (0.000)	1.295*** (0.000)	1.421
RWO	(1, 1)	-0.066** (0.018)	(1,1)	0.728*** (0.000)	1.957	-0.043 (0.148)	(2,2)	0.536*** (0.000)	1.409*** (0.000)	1.950
IFGL	(2, 2)	-0.030 (0.545)	(2,2)	0.485*** (0.000)	1.940	-0.056 (0.340)	(1,2)	0.420*** (0.000)	1.217*** (0.000)	1941
WPS	(2, 2)	-0.022 (0.619)	(2,2)	0.503*** (0.000)	1.908	-0.026 (0.526)	(1,2)	0.458*** (0.001)	1.258*** (0.000)	1.905
GRI	(1, 0)	-0.092* (0.068)	(2,1)	0.594*** (0.000)	1.962	-0.083 (0.135)	(1,1)	0.470*** (0.000)	1.528*** (0.000)	1.952
TAO	(2, 0)	-0.028 (0.460)	(1,2)	0.519*** (0.000)	2.392	-0.031 (0.531)	(1,2)	0.436*** (0.000)	1.493*** (0.000)	2.384
IFAS	(2, 2)	-0.024 (0.305)	(0,1)	0.643*** (0.000)	2.080	-0.021 (0.383)	(1,2)	0.491*** (0.000)	1.315*** (0.000)	2.073
IFEU	(2, 2)	-0.054*** (0.009)	(2,2)	0.696*** (0.000)	2.411	-0.066 (0.112)	(0,2)	0.141 (0.278)	2.154*** (0.000)	2.416

Note: *, ** and *** are significance at 10, 5 and 1% levels, respectively; p-values are in parentheses.

In identifying the best fitting models for US and Global REIT ETFs, this study utilized the maximum log-likelihood values. Table 8 shows that in isolating each type of model, ARMA-APARCH and ARFIMA-FIAPARCH models are the relatively better short memory and long memory models, respectively. ARMA-APARCH models best fit all ETFs in the US REIT category, while 5 (out of 8) ETFs can be better modeled in the Global REIT category except for VNQI, IFGL and WPS ETFs. On the other hand, ARFIMA-FIAPARCH models best fit almost all ETFs in the US REIT category except for PSR ETF, while 6 (out of 8) ETFs can be better modeled in the Global REIT category except for IFGL and IFEU ETFs. Overall results show that long-memory outperform short-memory methodologies in modeling REIT ETFs, except for KBWY US REIT ETF, which is best fitted under the ARMA-APARCH specifications. The power of fractionally integrated (FI) models over their non-FI counterparts is said to be statistically attributed to the hyperbolic rate of decay present long memory models compared to the exponential rate of decay in short memory models; and the allowance given to the difference parameter to be a non-integer offering greater flexibility in modeling time-series data. These findings has also been documented by Ruzgar and Kale (2007), Tansuchat et al. (2009), and Goudarzi (2010) in studying Istanbul stock exchange, commodity futures, and the Bombay stock exchange, respectively.

TABLE 8: US AND GLOBAL REIT ETFS LOG LIKELIHOOD

5	Short-memory models		Long-memory models	
	ARMA – EGARCH	ARMA - APARCH	ARFIMA-FIEGARCH	ARFIMA-FIAPARCH
VNQ	-2228.867	-2225.807^{sm}	-2223.439	**-2221.619**^{lm}
FNIO	-1897.428	-1893.984^{sm}	-1898.824	**-1890.633**^{lm}
KBWY	-453.722	**-449.982**^{sm}	-451.139	-450.370^{lm}
SCHH	-462.857	-460.279^{sm}	-457.107	**-453.734**^{lm}
REZ	-1775.904	-1770.766^{sm}	-1768.167	**-1761.611**^{lm}
PSR	-1212.957	-1209.670^{sm}	**-1184.916**^{lm}	-1226.575
FTY	-1761.144	-1758.607^{sm}	-1759.946	**-1755.722**^{lm}
Global REIT ETFs	**Short-memory models**		**Long-memory models**	
	ARMA – EGARCH	ARMA - APARCH	ARFIMA-FIEGARCH	ARFIMA-FIAPARCH
VNQI	-533.183^{sm}	-535.653	-529.019	**-525.051**^{lm}
RWO	-1336.414	-1332.182^{sm}	-1332.180	**-1325.596**^{lm}
IFGL	-1421.067^{sm}	-1424.206	**-1414.633**^{lm}	-1416.616
WPS	-1493.133^{sm}	-1494.014	-1485.303	**-1484.034**^{lm}
GRI	-1346.660	-1334.303^{sm}	-1336.271	**-1330.105**^{lm}
TAO	-1756.677	-1754.649^{sm}	-1757.876	**-1752.218**^{lm}
IFAS	-1518.916	-1516.751^{sm}	-1514.809	**-1507.512**^{lm}
IFEU	-1796.022	-1763.907^{sm}	**-1761.720**^{lm}	-1767.130

Note: ^{sm} and ^{lm} identify best fitting model for short and long memory models, respectively; bold-faced values identify the best fitting models

5. DISCUSSIONS AND LIMITATIONS

This study examines the performance of FI and non-FI return and volatility models containing long-memory, asymmetric volatility, and leverage effects by comparing two categories of REITETFs, namely, US REIT ETFs and Global REIT ETFs.These ETFs are a basket of portfolios that invests in companies that own and operate portfolios of commercial and residential real estate. The research follows the objective initially presented in this study. First, the study finds existence of volatility clustering, leverage effects and volatility asymmetry phenomena in both US and Global REIT ETFs, which means that the recent subprime mortgage crisis has a global impact, negatively affecting both local and overseas real estate related investments. Second, longmemory models are better in characterizing future values using lagged returns and volatilities compared to their short memory counterparts. Although, non-FI models have more significant results, the maximum log-likelihood values show that FI models are better in capturing future returns and volatilities.

This study also finds evidences of volatility clustering, leverage effects, and volatility asymmetry, which suggest that high volatility regimes like that of the subprime mortgage crisis in 2008 has a global impact that negatively affects both US and Global REIT ETFs. And that fund managers and investors diversifying their REIT portfolios are not hedged against local risks. Third, the study finds positive long-term dependence in the volatilities of both ETFs, however, predictability is not present in the returns, thus, failing to conclude dual long memory processes. Nevertheless, the research still can pose a challenge on the weak-form EMH of Fama (1970), because historical values of REIT ETFs can still be used to predict their future behavior through their conditional variance. Traders can still expect to have abnormal returns in trying to predict REIT ETFs using advanced technical analysis tools. Lastly, US REIT ETFs are seen to be more unstable than their more stationary Global REIT ETFs counterparts, because of some non-stationary and non-invertible properties observed in returns and volatilities, respectively.

The study provides an initial step for the prediction of US and Global REIT ETFs, however, one limitation of this paper is that it did not specifically identify the type of forecast (i.e., one-step ahead, two-step ahead forecasts, and its extensions) suitable for the given set of time-series. This can be considered in the future and a viable extension of this paper. Also, the recent subprime mortgage crisis of 2008 could have been a good opportunity for structural break tests, however, dividing the data would leave the other half unfit for conclusive results because of a very short timeline. The research also focuses on REIT ETFs that were only subjected to specified test, future studies can also apply other methodologies in the FI family using other types of ETFs.

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