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Gold market volatility and REITs' returns during tranquil and turbulent episodes

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ABSTRACT

We analyze the predictability of REIT returns based on gold market volatility for 11 sectors and five regions. Our findings show higher gains during volatile gold market conditions, but results vary in tranquil and turbulent periods. We observe sector-specific investment behavior in the REITs market during the pre-GFC, but the post-GFC and COVID periods show otherwise. REITs offer a safe haven ability for gold, but their hedging power is sector-specific. For sensitivity analysis, stock market volatility is used in lieu of gold market volatility, and the outcome provides the expected counterfactual evidence with the REITs market. Our study has numerous policy implications for global financial market stakeholders.

1. Introduction

Literature is copious on the hedge and safe haven features of gold and other commodity assets (see Akinsomi, Aye, Babalos, Economou, & Gupta, 2016; Anoruo, 2019; Yunus, 2020) with inconclusive evidence. In many of the prior studies, the hedge and safe haven evidence is more pronounced only between gold and equities, and it is also found to be period-specific (mostly during economic turbulence and short-lived afterwards). In other words, the functionality of assets (especially gold) for hedging is time-dependent for specific economic conditions and specific data ranges (see Salisu, Swaray, & Oloko, 2019 and cited articles therein). While this evidence is obvious for gold and other classes of assets like bonds and stocks, studies on the gold – Real Estate Investment Trusts (hence REITs) nexus have not been vigorously emphasized in the literature. In particular, an effort to test the shared connection between gold market returns and its volatility concerning its equivalence in the REITs market is lacking candid attention. There is some evidence to suggest that gold prices tend to appreciate during times of crisis, but there has not been a clear empirical test to prove that gold is a safe haven for REITs. The available evidence only suggests that crises do not affect the returns of both instruments, as reported by (see Sumer & Ozorhon, 2021). Therefore, we are interested in conducting a thorough investigation into the impact of gold price volatility on REIT returns, both by sector and by region.

Conventionally, gold and REITs are regarded as defensive assets. Defensive assets can be used as a hedge against uncertainty arising from inflation or any global crisis (see Akinsomi et al., 2016; Anoruo, 2019; Yunus, 2020). However, while investors often seek to reduce the risk emanating from asset price fluctuations, crisis in the financial market can further sabotage such efforts. By implication, many investors are risk-averse as they are found to utilize any available avenue to maximize returns and reduce risk (see Mamcarz, 2015). Various accounts have assumed similar features for REITs and, additionally, for being sector-specific (Christou, Gupta, Nyakabawo, & Wohar, 2018; Taderera & Akinsomi, 2020).

Further accounts have also emphasized the beneficial role of gold for portfolio diversification, albeit with no consensus on whether this benefit transcends periods of economic turmoil and turbulence (see Yunus, 2020 and various articles cited therein). However, the available empirical literature shows that in a volatile period of economic

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conditions, the essential role of gold in serving as a safe haven may not hold (see Yunus, 2020). There are numerous studies on the hedging ability of gold about other financial assets such as stocks and bonds (Beckmann, Berger, & Czudaj, 2015; Bredin, Conlon, & Potì, 2015), there are also ample findings on REITs concerning other commodity assets for portfolio diversification (see Bouri, Gupta, & Wang, 2022). But studies that emphasize portfolio diversification between gold and REITs in any particular direction are very scarce. The benefits of REITs in the management of investment portfolios include their role in asset allocation, risk reduction and diversification. These benefits have been particularly observed during periods of economic uncertainty (see Akinsomi et al., 2016; Bonato, Çepni, Gupta, & Pierdzioch, 2021; Chandrashekaran, 1999; Chaudhry, Christie-David, & Webb, 2010; Chun, Sa-Aadu, & Shilling, 2004; Fugazza, Guidolin, & Nicodano, 2009; Hudson-Wilson, Fabozzi, & Gordon, 2003; Hung, Onayev, & Tu, 2008; Lee & Stevenson, 2005; Lu, Tse, & Williams, 2013; Marfatia, Gupta, & Cakan, 2017; Zhong, 2013).

REITs' returns have been found to increase during periods of negative economic shocks, which translates into a contraction in the economy. Demirer, Gupta, Pierdzioch, and Hussain Shahzad (2021) demonstrate that shocks in the oil market can be used to predict volatility in gold returns. Volatility in the gold market in turn, has also been found to lead to volatility in the broader stock and REIT markets (Bonato et al., 2021). Huang and Lee (2009) noted that during periods of supply shocks which result in the contraction of an economy, REIT returns increase as investors increase their demand for REITs and trading in REIT shares spikes, resulting in higher REIT volatility. Conversely, during periods of positive demand shocks, REIT returns decrease, as an expansion in the economy results in REITs being substituted by what the authors describe as "conventional assets". The lower REIT returns result in lower volatility in REIT markets as trading in REIT shares falls.

While no thorough investigation exists between these two forms of assets, some of the benefits of investing in REITs and gold have been offered in the literature. As for REITs, aside their categorization as long-term investments, they provide investors with liquidity flows for further financial transactions (see Anoruo, 2019). Gold also shares similar features with REITs, as it is easily convertible to the economy's medium of exchange and can be hedged against financial crises during turbulent times. Gold is also durable and easily traded (see Anoruo, 2019). By composition, REITs can be Equity, mortgage or hybrid (see Anoruo, 2019; Sumer & Ozorhon, 2021). While equity REITs entail investing in real estate by generating returns through rent collection, mortgage REITs provide debt funding for intending estate developers directly or through financial institutions at existing interest rates (see Lee & Chiang, 2004). The All (hybrid) REITs portfolio combines the two REIT forms, equity and mortgage (SEC, 2011). Globally, investment in REITs has been enormously/graciously embraced. The Global REITs market capitalization alone reached 35 trillion US dollars in 2020 from a low value of about 1.7 trillion US dollars in 2016, while 217 trillion US dollars is further accounted for by developed market real estate sectors, both residential and non-residential. This amount makes up around 60% of total global assets (see NAREIT, 2023; Sumer & Ozorhon, 2021). At the same time, the tune of gold mining globally has been on the increase, though very small compared to REITs. Only a total of 6 trillion US dollar worth of gold is on record to have ever been mined globally (see report by Savills, 2021).

Past literature on the gold and REIT markets has shown mixed results on these assets' inflation hedging characteristics. For instance, Larsen and McQueen (1995) examine the hedging properties of gold and compare this against gold stocks. Gold is shown to perform well as an inflation hedge, while gold reserves do not. The study suggests that caution must be exercised when interpreting results of studies regarding an underlying asset and a securitized asset. The study also refers to REITs, which are securitized. Some of the results of studies that analyze the inflation hedging characteristics of REITs are mixed and contradictory. Park, Mullineaux, and Chew (1990) examine the inflation hedging characteristics of REITs; the authors find that REITs behave more like stocks and are indistinguishable and are pervasive inflation hedges. Chatrath and Liang (1998) add to the discourse on the role inflation plays in REIT returns; their findings, in line with past work, show that there is no evidence that REIT returns are related to temporary or permanent components of inflation. However, the study finds some evidence that REITs provide a long-run inflation hedge. Akinsomi, Balcilar, Demirer, and Gupta (2017) show the connectedness of the gold market to the REIT market; the authors find that a high level of speculation in the gold market significantly contributes to herding in the emerging REIT market in South Africa and at specific periods between 2008 and 2011. Sumer and Ozorhon (2021) examine the gold and REIT markets in Turkey; the results show that in times of crisis, such as the COVID-19 pandemic, the 2008 global financial crisis, and the Turkish currency crisis, the gold market performed better than REITs. The study highlights that the REIT market index is riskier than the gold index and recommends that fund managers include both assets for diversification in a portfolio.

In asset allocation, assets whose returns do not move in the same direction make for better optimization in returns; for instance, Jacobs, Müller, and Weber (2014) conclude that a well-balanced allocation over different asset classes drives diversification gains, which is further buttressed in the Sumer and Ozorhon (2021) paper which found that the inclusion of gold and REITs assets in a portfolio could optimize asset allocation. In a way, the differing stance between returns for gold and REITs may contribute to portfolio diversification between the two forms of assets. The main idea being presented resonate in justifying possible reason why portfolio diversification is possible between gold and REITs when the gold market is particularly volatile.

The foregoing discussion suggests that investigating the connection between gold and REITs is worthy of attention. Unlike similar prior studies (like Akinsomi et al., 2016; Anoruo, 2019; Sumer & Ozorhon, 2021), our investigation takes a global view of this nexus. We categorize REITs at sectoral and regional levels. Following the FTSE/NARIET classification structure, we categorize REITs into eleven sectors: diversified, healthcare, Industrial/office, Industrial, Lodging/Resorts, Office, Rental, Residential, Retail, Self-Storage and Specialty. Geographically, we group REITs into five regions (i.e., Developed, Developed Europe, Middle East and Africa (EMEA), Emerging EMEA, Emerging and Global. Investments in different Real Estate Investment Trusts (REITs) are subject to variations at sectoral and regional levels. These variations can have significant implications on the outcome of the investment. For example, diversified REITs that include all types of commercial and private REITs generally promise all-time returns, while specialty REITs that only focus on specific areas like student housing, prisons, and cinema centers may have region-specific returns that are limited to a specific period. The performance of the REITs sector can be attributed to the varying nature of the concerned economy in terms of its sector composition, income, and various macroeconomic factors such as inflation, interest rates, and stock indices (Khan & Siddiqui, 2019).

Specifically, we emphasized how volatility in the gold market may contribute to improving returns in the REITs market in the pre-crisis periods (such as periods before the global financial crisis [pre-GFC] and COVID-19 pandemic) and during these crises (such as during GFC and COVID-19) in a predictive manner using the Westerlund and Narayan (2015) autoregressive approach. This approach is important to address the persistence, endogeneity, autocorrelation and heterogeneity problems that may be inherent in any time series data, as in the case of the present study.

As previously mentioned, gold prices often soar in crisis, and anecdotal evidence holds that rising gold prices benefit investors since prices of other assets always fall during this period. But suppose the gold price decreases at the same time that the prices of other assets (especially REITs) fall considerably, there will be no possibility of hedging gold for other assets. Being a stable and long-term investment, REIT prices do not often fall but rise steadily and permanently, and this may provide a basis

for hedging REIT for gold instead. Our finding thus provided empirical guidance on this possibility in the various periods, as suggested by the focus of this study. Our emphasis is further argued using both in-sample and out-of-sample forecast estimations. This is indeed necessary to ensure a convincing performance of our overall estimation. This estimation is further confirmed for the full sample, pre-GFC, during GFC to pre-COVID-19, and COVID-19 periods. To account for the sensitivity of our analysis, stock volatility is used in lieu of gold, and the outcome confirms the robustness of the baseline evaluation. Analysis of this nature concerning gold volatility and REITs return has not been upheld previously in the literature.

As a prelude to our estimated outcomes, our results confirmed the following for the in-sample estimation. Rising volatility in the gold market consistently results in higher gains for investors in the REITs market for the full sample analysis. However, more information becomes unfolded when the periods are sectionalized. In the pre-GFC era, the substitution of gold for REITs when the gold market is volatile is more profitable in many sectors and otherwise for others. By implication, in the pre-GFC period, the safe haven ability of REITs for gold when the market for the latter is volatile is only considered sector-specific. In the period after the GFC and up to the COVID-19 era and beyond, REIT returns are exceptionally rising across sectors and regions when the gold market is volatile. This further suggests that REITs market is a safe haven for gold when the financial market is not stressed but where the gold market is rather volatile. Our result implies that REITs are a safe haven for gold, but their hedging ability is confirmed to be sector and region-specific. However, our out-of-sample evaluation further confirmed the out-performance of the in-sample estimation, where the estimated parameters exhibit required values and signs. In the alternative estimation where stock volatility is adopted instead of gold for robustness check, the estimated outcome is confirmed to be sensitive to the baseline evaluation.

Following this introduction, our further discussion takes the following orders. While we address the data issue and methodology in section 2, the empirical finding is discussed in section 3, and section 4 concludes.

2. Data Issues and Methodology

The data employed in this study comprise daily returns of eleven REIT sectors (Diversified, Healthcare, Industrial/office, Industrial, Lodging/Resorts, Office, Rental, Residential, Retail, Self-Storage and Specialty) and five regions (Developed, Developed EMEA, Emerging EMEA, Emerging and Global), and gold (as well as aggregate stock for robustness) realized volatility, spanning February 15, 2007 and January 31, 2023. The return data for REITs is sourced from the FTSE EPRA NAREIT Global Real Estate Index series. This index series represents the general performance of real estate firms globally. The index covers both developed and emerging markets. Aggregate stock data is obtained from the FTSE Global Equity Index series which covers over 16,000 listed stocks across 48 developed and emerging countries globally. The Goldman Sachs Commodity index series serves as the source of our commodity return data. The index covers a broad range of commodity sectors and is calculated on an unleveraged, long-only and fully collateralized basis.

The realized volatilities for the gold, REIT and aggregate stock data are obtained by taking the summation of the squared returns over a 20-day rolling window framework. The originally existing REITs, gold and stock prices are transformed given the focus of this paper to examine the nexus between REIT returns, and gold (stock) realized volatility. We summarize the data in Table 1 with some summary statistics (mean, standard deviation, skewness and kurtosis) and relevant preliminary analyses (ARCH effect, serial correlation and persistence).

The average returns on REITs are mostly negative under the sectoral classification (except in the cases of healthcare, industrial, rental, residential and self-storage) and under the regional classification (except in

Table 1
Summary Statistics and Preliminary Analyses.

REITs	Summary Statistics					Conditional Heteroscedasticity			Autocorrelation						Pers
	Mean	CV	Skew	Kurt	N	*ARCH*(1)	*ARCH*(5)	*ARCH*(10)	Q(1)	Q(5)	Q(10)	$Q^2(1)$	$Q^2(5)$	$Q^2(10)$	
Sectoral REIT Returns															
Diversified	−8.89E-03	247.02	−0.42	20.04	4164	264.70***	266.35***	161.10***	0.01	10.38*	30.56***	249.22***	2103.40***	3914.80***	−0.16***
Healthcare	1.11E-03	1882.89	−0.77	22.18	4164	302.89***	284.26***	149.25***	0.04	16.02**	26.58***	282.73***	2201.30***	3138.40***	−0.13***
Inds/Off	−1.30E-02	188.35	−0.91	26.97	4164	570.75***	313.88***	173.69***	0.07	22.72***	64.72***	502.61***	2622.60***	4075.90***	−0.14***
Industrial	5.16E-03	513.89	−0.94	27.59	4164	699.82***	360.22***	252.24***	0.13	11.07*	43.29***	599.90***	2982.40***	5726.80***	−0.16***
LDG/Resorts	−1.53E-02	177.31	−0.10	17.36	4164	320.87***	274.14***	143.36***	0.04	21.76***	39.15***	298.32***	2238.20***	3708.80***	−0.10***
Office	−1.49E-02	144.11	−0.45	20.86	4164	215.71***	273.62***	168.07***	0.01	15.85**	31.59***	205.37***	1962.30***	3708.30***	−0.17***
Rental	5.76E-03	356.22	−0.56	19.83	4164	229.58***	251.57***	154.41***	0.04	9.70*	34.05***	217.89***	1953.70***	3629.10***	−0.21***
Residential	1.33E-02	154.23	−0.38	19.39	4164	368.01***	274.47***	172.38***	0.00	20.45***	32.26***	338.58***	2201.10***	4129.70***	−0.17***
Retail	−9.81E-03	232.93	−0.60	23.62	4164	169.52***	242.06***	129.21***	0.12	21.75***	38.09***	163.12***	1811.50***	2955.20***	−0.13***
Self-Storage	2.93E-02	67.30	−0.11	16.59	4164	347.10***	223.79***	140.49***	0.03	27.63***	33.24***	320.83***	1699.80***	3268.20***	−0.16***
Specialty	−7.43E-03	349.67	−0.46	8.91	1002	20.49***	32.95***	28.11***	0.01	9.26	20.56**	20.19***	232.41***	545.23***	−0.15***
Regional REIT Returns															
Developed	−5.98E-03	206.46	−0.98	17.71	4164	150.40***	265.15***	147.69***	0.27	22.71***	41.12***	145.36***	1740.50***	2801.80***	0.13***
DEV EMEA	6.63E-03	195.42	−0.78	12.80	3296	57.39***	97.02***	65.55***	0.05	9.98*	27.07***	56.51***	674.14***	1185.00***	0.09***
EM EMEA	−4.40E-03	320.25	−0.79	12.29	3717	91.05***	252.13***	134.51***	0.01	8.28	20.29**	89.01***	1477.30***	2067.90***	0.08***
Emerging	−5.52E-03	217.44	−0.19	7.57	2909	330.90***	145.77***	75.60***	0.00	3.02	30.74***	297.66***	1205.50***	1576.30***	0.14***
Global	8.82E-03	104.64	−2.03	36.40	2909	71.11***	283.65***	189.03***	0.97	70.28***	110.74***	69.55***	1385.80***	1880.50***	0.15***
Realized Volatilities															
Gold	2.45E+01	1.08	3.41	17.70	4164	5.21**	1.79	1.11	37.58***	54.20***	69.99***	5.21**	9.35	12.00	0.98***
Stock	2.56E+01	2.03	5.59	39.38	3932	17.48***	161.04***	102.74***	23.28***	675.87***	977.46***	17.43***	857.12***	1308.10***	0.99***

the cases of Developed EMEA and global). Healthcare REITs appear to be the most volatile, while Self-Storage REITs exhibit the least volatility. All the REIT returns across sectoral and regional classifications are found to be negatively skewed and leptokurtic, which is typical of return series. There are clear indications of conditional heteroscedasticity, first-order serial correlation (except in the case of lag 1), and higher-order serial correlation in the REIT returns across the specified lags and under the sectoral and regional classifications. On the other hand, the realized volatility of the gold and aggregate stock markets are positively skewed and more peaked than normal. There are indications of persistence in all the series (REIT returns, gold realized volatility and stock volatility) employed in this study. However, the persistence in gold and stock is very high, closer to unity. The afore-observed features, therefore, guide our choice of modelling framework. The most appropriate in this case is the Westerlund and Narayan [WN] type autoregressive distributed lag model based on the feasible generalized least squares model framework. The framework allows for simultaneous incorporation of the autoregressive nature of the response variable and the exhibited evidence of conditional heteroscedasticity, as well as correcting for the inherent persistence in the predictors.

Given the focus of the study, we present a graphical representation of the dynamics of the relationship between REIT returns and gold market volatility. Figs. 1 and 2 show that the REIT returns are characterized by volatility clustering and jumps indicative of structural breaks. This subjective evidence of structural break(s) is formally confirmed using the Bai and Perron (2003) multiple breakpoint tests, which provide statistical significance of the observed breaks. Subsequently, such significant breaks are incorporated into the predictive model for REIT returns. Also, there are reasonable co-movements between REIT returns and gold realized volatility, with indications of the REIT returns becoming more unstable when gold realized volatility is heightened. Again, this subjective positive co-movement is formally confirmed using our choice predictive model – the Westerlund and Narayan-type autoregressive distributed lag model.

On the model framework, we consider the Westerlund and Narayan [WN] type autoregressive distributed lag model that is based on the feasible generalized least squares regression framework as our predictive model to examine the REIT returns – gold realized volatility nexus. This is informed by the characteristic high-frequency nature of our data, with evidence of one or more salient features (persistence, endogeneity, conditional heteroscedasticity, among others) cum the merits of the WN-type model to accommodate these salient features within a single framework adequately. The predictive model is defined in eq. (1) as:

$$reit_t = \alpha + \delta reit_{t-1} + \sum_{i=1}^{k} \beta_i gold_{t-i} + \phi\, \Delta gold_t + \sum_{j=1}^{m} \lambda_j brk_{j,t} + \varepsilon_t \tag{1}$$

where $\alpha, \delta, \beta_i^{'}s, \phi, and\ \lambda_j^{'}s$ are the predictive model parameters to be estimated; $reit_t$ and $reit_{t-1}$ denote, respectively, the REIT returns at times t and $t-1$; $gold_{t-i}$ denotes the lagged realized volatility of gold, with $i = 1, 2, \ldots, k$ and $k = 5$ to depict the business day feature of the data; $brk_{j,t}$ represent j break dummies which correspond to the significant breakpoints inherent in the REITs series, determined by the Bai and Perron (2003) multiple breakpoint test, and indicative of the structural break date associated with the REIT returns; while ε_t represents the disturbance term. The term, $\Delta gold_t$, is incorporated to adjust for the observed persistence in the gold realized volatility. We include endogenously determined break dummies in our predictive model to appropriately model the dynamics such high-frequency and lengthy data series may exhibit, covering several significant historical economic and financial events. The model in eq. (1) is pre-weighted with the standard deviation of the residuals from ARCH, its ARCH-based variant, to correct for the inherent conditional heteroscedasticity. Our predictive model is subsequently compared with its subset – an $AR(1)$ based model, which is considered, in this study, as the benchmark model. For robustness, the aggregate stock-realized volatility is used in place of gold-realized volatility.

In this study, our interest lies in ascertaining the REIT returns – gold volatility nexus (which is indicated by $\sum_{i=1}^{k}\beta_i$ in our predictive model) while accounting for inherent persistence and plausible structural breaks. Our a priori expectation is a positive nexus between REIT returns and gold market volatility, where heightened uncertainty in the gold market is expected to lead to gains in the returns on REITs. Essentially,

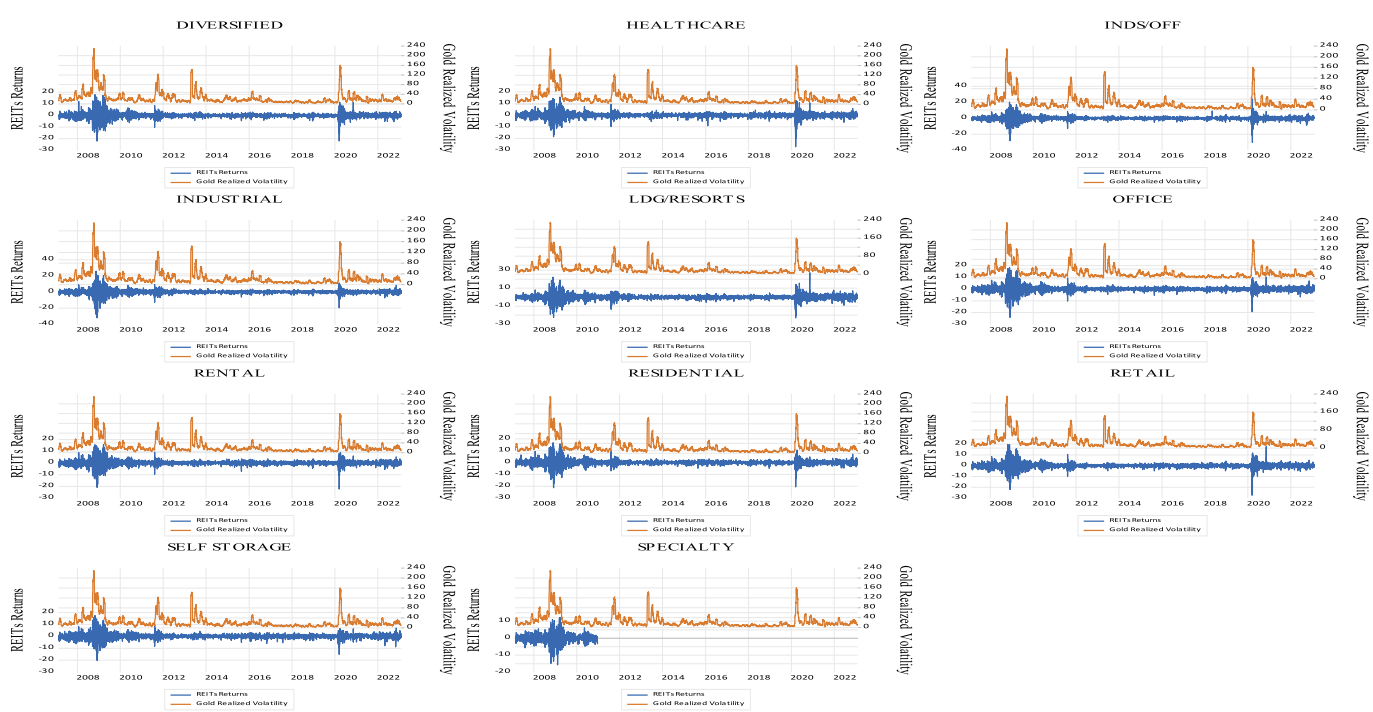

Fig. 1. Co-movement of Sectoral REIT Returns and Gold Market Volatility. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

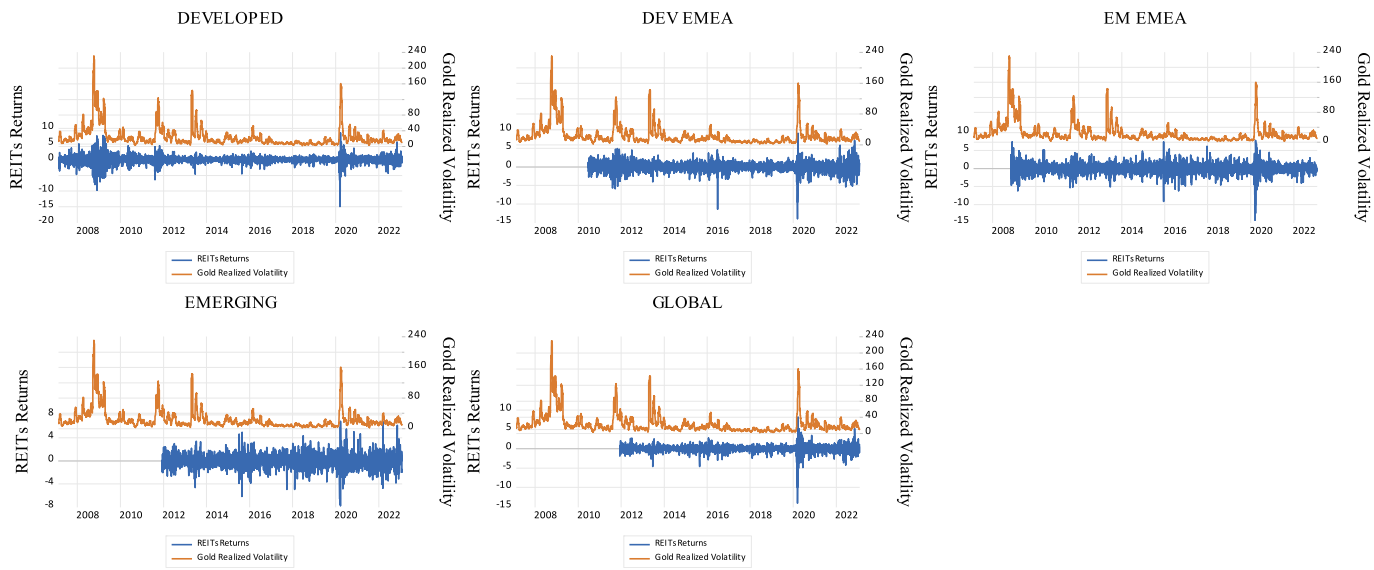

Fig. 2. Co-movement of Regional REIT Returns and Gold Market Volatility. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

REITs may be expected to serve as a safe haven during price crises in the gold market. Consequently, the statistical significance of gold realized volatility is obtained using the Wald Statistics, and it depicts gold realized volatility as a relevant predictor for REIT returns.

We adopt the Clark and West [CW] (2007) test to examine our predictive model against the benchmark model for out-of-sample forecast performance. The essence is to ascertain whether the in-sample predictability result transcends the estimation sample period since the outcome of the in-sample predictability cannot be used to generalize for the out-of-sample predictability, and more importantly, forecast accuracy is better determined with out-of-sample forecasts ((Narayan & Gupta, 2015; Salisu et al., 2019). The CW test compares the forecast precision of two contending nested models and tests that their obtained forecast error difference is not different from zero. The underlying procedure for the CW test involves calculating eq. (2):

$$\widehat{f}_{t+k} = \left(r_{t+k} - \widehat{r}_{1t,t+k}\right)^2 - \left[\left(r_{t+k} - \widehat{r}_{2t,t+k}\right)^2 - \left(\widehat{r}_{1t,t+k} - \widehat{r}_{2t,t+k}\right)^2\right] \quad (2)$$

where k is the forecast period, $\left(r_{t+k} - \widehat{r}_{1t,t+k}\right)^2$ is the squared error for the restricted model, $\left(r_{t+k} - \widehat{r}_{2t,t+k}\right)^2$ is the squared error for the unrestricted model, and $\left(\widehat{r}_{1t,t+k} - \widehat{r}_{2t,t+k}\right)^2$ is the adjusted squared error introduced by the CW test to correct any noise associated with the larger model's forecast. Thus, the sample average $\widehat{f}_{t+k}$can be expressed as $MSE_1 - (MSE_2 - \text{adj.})$, and each term is computed as $MSE_1 = P^{-1}\sum\left(r_{t+k} - \widehat{r}_{1t,t+k}\right)^2$, $MSE_2 = P^{-1}\sum\left(r_{t+k} - \widehat{r}_{2t,t+k}\right)^2$, and $\text{adj.} = P^{-1}\sum\left(\widehat{r}_{1t,t+k} - \widehat{r}_{2t,t+k}\right)^2$, where P is the number of predictions used in computing these averages. The equality of the restricted and unrestricted models' forecast errors is tested by regressing $\widehat{f}_{t+k}$ on a constant. The resultant t-statistic associated with the estimated constant is used to make an inference. The null hypothesis asserts the equality of MSEs against a mutually exclusive alternative and is tested under standard significance levels.

3. Empirical results

3.1. In-sample predictability

The estimation results for our predictive model are presented in Table 2 under four different sub-period categorizations – full sample, pre-GFC, GFC to Pre-COVID and COVID to date. These breakpoints are

Table 2
In-Sample Predictability (REITs Return – Gold RV nexus).

	Full	Pre-GFC	GFC-Pre-COVID	COVID
Sectoral REITs				
Diversified	1.43E-03***	−1.73E-03**	9.14E-04***	8.29E-03***
	[1.49E-04]	[7.41E-04]	[1.25E-04]	[9.06E-04]
Healthcare	2.22E-03***	1.82E-03***	3.11E-03***	1.72E-02***
	[1.28E-04]	[1.64E-04]	[2.88E-04]	[1.50E-03]
Inds/Off	2.54E-03***	2.28E-03**	2.93E-03***	6.64E-03***
	[1.09E-04]	[9.98E-04]	[1.93E-04]	[3.84E-04]
Industrial	2.02E-03***	−4.68E-03***	2.34E-03***	1.97E-03***
	[8.93E-05]	[6.00E-04]	[2.65E-04]	[1.92E-04]
LDG/ Resorts	2.99E-03***	1.03E-03*	3.14E-03***	6.50E-03***
	[7.56E-05]	[5.38E-04]	[1.22E-04]	[4.79E-04]
Office	2.25E-03***	−2.71E-04	1.31E-03***	5.22E-03***
	[2.97E-04]	[5.34E-04]	[1.18E-04]	[4.83E-04]
Rental	3.38E-03***	8.43E-05	3.48E-03***	5.88E-03***
	[1.68E-04]	[7.64E-04]	[1.87E-04]	[8.13E-04]
Residential	8.44E-04***	−1.61E-03***	4.27E-04***	7.76E-03***
	[4.91E-05]	[4.22E-04]	[2.16E-05]	[1.28E-03]
Retail	2.42E-03***	2.08E-03	2.92E-03***	9.20E-03***
	[8.23E-05]	[1.47E-03]	[1.60E-04]	[2.08E-03]
Self-Storage	2.97E-03***	6.85E-03***	2.33E-03***	9.65E-04***
	[1.45E-04]	[1.35E-03]	[4.01E-04]	[2.45E-04]
Specialty	−1.75E-03***	−3.69E-03***	–	–
	[2.37E-04]	[3.98E-04]		
Regional REITs				
Developed	8.21E-04***	−3.82E-03***	1.03E-03***	8.33E-03***
	[1.42E-04]	[4.79E-04]	[7.28E-06]	[4.21E-04]
DEV EMEA	2.35E-03***	–	3.41E-03***	2.84E-03***
	[1.38E-04]		[2.54E-04]	[7.56E-04]
EM EMEA	3.93E-03***	–	2.50E-03***	4.19E-03***
	[4.06E-04]		[1.53E-04]	[2.07E-04]
Emerging	6.21E-04***	–	3.25E-04**	2.82E-03***
	[7.72E-05]		[1.41E-04]	[8.10E-04]
Global	2.15E-03***	–	1.41E-03***	6.10E-03***
	[1.60E-04]		[1.69E-04]	[7.57E-04]

Note: The figures in each cell are the sum of the five lags of gold realized volatility and their corresponding standard errors, with the Wald-determined statistical significance denoted as ***, ** and * for 1%, 5% and 10% significance levels, respectively. The cell with "-" indicates cases where there are not enough observation points to estimate our predictive model.

exogenously determined, given certain specific global historical events. However, we consider endogenously determined breaks in the form of dummy variables to model the dynamics in the examined nexus fully. The model estimated and reported is, therefore, the WN-type autoregressive distributed lag model that incorporates five lags of gold realized volatility as predictors as well as formally determined breakpoints. The estimation is conducted for the sectoral (upper horizontal panel of Table 2) and the regional (lower horizontal panel of Table 2) REITs categorizations. The reported figures are the estimated sum of the slope coefficients associated with the five lags of gold realized volatility and their corresponding standard errors, with significance determined by the conventional Wald test.

Under the full sample period categorization, we find in-sample predictability of gold realized volatility for sectoral and regional REIT returns. The nexus between REIT returns and gold realized volatility is found to be significantly positive across the sectors (except in the case of Specialty, where a significantly negative nexus is observed) and across the regions. This result is indicative that over the full sample period, on average, higher volatility in the gold market would result in higher gains for investors in the REIT market. This stance holds irrespective of the period being considered. However, given that peculiarities characterize different periods, this result is further subjected to sub-period examinations.

If the REIT returns – gold realized volatility is homogenous across the sub-periods, we consider three additional sub-period characterized by recorded global events – GFC and COVID. We find the nexus to be mixed under the pre-GFC sample period, with gold realized volatility having a significantly positive relationship with Healthcare REITs, Industrial/Office REITs, Lodging/Resorts REITs, and Self-Storage REITs, and a significantly negative relationship with Diversified REITs, Industrial REITs, Office REITs, Residential REITs, and Specialty REITs. Interestingly, the negative nexus earlier observed for Specialty REITs under the full sample, which is also confirmed under the pre-GFC sample period, results from the available data that spans a little over the pre-GFC sample period. The nexus is negative in the regional classification under the pre-GFC sample period. For sub-periods from the GFC onwards, the nexus is consistently significantly positive, irrespective of the sectoral or regional REITs categorization being considered. Consequently, REIT returns – gold realized volatility nexus is homogeneous in the cases of Healthcare, Industrials/Office, Lodging/Resorts, and Self-Storage REITs; and heterogeneous in the cases of Diversified, Industrial and Residential REITs. Under the regional classification, the nexus is homogeneous across the regional REITs except in the case of Developed markets. This outcome sheds light on the nature and features of various type of REITs. Importantly, investment in REITs is subject to some level of variation either at sectoral or regional levels and this variation may explain some differing stance as exhibited in the result outcome. By further implication, the performance of REITs sector can be explained by the differing nature of the respective economies in terms of their sector compositions, income and various macroeconomic factors such as inflation, interest rate and stock market capitalisation (see Khan & Siddiqui, 2019). While emphasizing the extent to which gold can be a hedge for REITs, Triki and Maatoug (2021) came to the submission that gold can be a better hedge for aggregate stocks in periods of crises than otherwise. Hence, the differing nature of the results between the sectionalized periods may be explained on the basis of presence or otherwise of a financial crisis.

3.2. Forecast evaluation

Following the in-sample predictability result in Table 2, we further examine forecast performance both in the in-sample (Table 3a) and specified out-of-sample (Table 3b) periods using the conventional Clark and West (2007) test. For the out-of-sample forecast evaluations, we consider 22-day (1-month), 66-day (3-months) and 132-days (6-months) ahead forecast horizons under the four different sub-sample periods and REITs categorizations (sectoral and regional). Our predictive model's forecast precision is contrasted with the benchmark model – an autoregressive model of order one. We adjudge that our predictive model is the preferred model whenever the CW statistic is positive and statistically significant; and the benchmark whenever the CW statistic is negative and statistically significant; otherwise, both contending models do not differ.

Table 3a
Clark and West In-Sample Forecast Evaluation (REITs – Gold nexus).

	Full	Pre-GFC	GFC-Pre-COVID	COVID
Sectoral REITs				
Diversified	3.04E-02*	1.34E-01***	1.92E-02***	6.35E-02***
Healthcare	2.21E-02***	9.34E-02***	2.35E-02***	2.18E-01***
Inds/Off	2.17E-02***	7.35E-02***	3.05E-02***	1.48E-01***
Industrial	4.42E-02***	9.43E-02***	2.39E-02***	1.96E-02***
LDG/Resorts	4.53E-02***	1.38E-01***	6.95E-02***	7.68E-01***
Office	3.01E-02***	6.87E-02***	2.55E-02***	2.16E-01***
Rental	2.86E-02***	4.25E-02***	2.50E-02***	8.92E-02***
Residential	1.73E-02***	6.23E-02***	1.60E-02***	9.77E-02***
Retail	2.82E-02***	6.10E-02***	2.44E-02***	3.18E-01***
Self-Storage	3.82E-02***	7.60E-02***	3.03E-02***	1.06E-01***
Specialty	2.07E-01***	3.33E-02***		
Regional REITs				
Developed	6.87E-03***	8.46E-02***	1.27E-02***	9.12E-02***
DEV EMEA	1.37E-02***	–	1.77E-02***	1.03E-01***
EM EMEA	2.63E-02***	–	2.55E-02***	4.22E-02***
Emerging	5.02E-03***	–	1.21E-02***	1.07E-01***
Global	5.31E-03***		1.05E-02***	9.03E-02***

Note: The figures in each cell are the CW statistics that compare our predictive model with a benchmark AR(1) model. Positive and statistically significant CW statistics indicate a preference for our predictive model over the benchmark model. The ***, ** and * denote 1%, 5% and 10% significance levels, respectively.

In the in-sample period, the out-performance of our preferred model over the benchmark is overwhelmingly consistent, irrespective of the REIT categorizations and sub-sample periods (full, Pre-GFC, GFC to Pre-COVID and COVID), which is not unexpected. This further confirms the in-sample predictability result presented in Table 2. However, the in-sample predictability stance is not fully replicated in the out-of-sample periods. Under the full sample period, the out-performance of our predictive model over the benchmark across the three specified forecast horizons is observed in all but four sectors (Healthcare, Industrial/Office, Residential and Retail) and only two regional categories (Developed EMEA and Emerging EMEA). Under the Pre-GFC sample period, there is no marked difference in the forecast precisions of our predictive model and the benchmark, except for the 22-day forecast horizon in the case of Diversified and Lodging/Resorts. Interestingly, more cases of out-performance favor our predictive model over the benchmark model under the GFC-Pre-COVID and COVID sub-sample periods and REITs categorizations (sectoral and regional). The takeaway is that incorporating lags of gold realized volatility as predictors, with its persistence adjustment and incorporation of structural breaks, contributes significantly towards improving the forecast precision both in the in-sample and specified out-of-sample periods.

3.3. Economic significance

Here, we examine the economic gains of the incorporated lags of gold realized volatility as predictors for REIT returns by sector and region. This is essential to lend economic-based support to the statistical conclusions earlier reached by the CW tests and confirm whether the incorporated predictors are economically relevant. The economic gains of our predictive WN-type autoregressive distributed lag model that incorporate gold realized volatility as a predictor and accounts for notable structural breaks are compared with the conventional autoregressive variant of lag order one.

Table 3b
Clark and West Out-of-Sample Forecast Evaluation (REITs – Gold nexus).

		Full	Pre-GFC	GFC-Pre-COVID	COVID
Sectoral REITs					
Diversified	$h = 22$	3.00E-02*	1.11E-01*	1.91E-02	6.01E-02
	$h = 66$	2.95E-02*	2.28E-01	1.89E-02	5.46E-02
	$h = 132$	2.91E-02*	1.17E-01	1.83E-02	4.70E-02
Healthcare	$h = 22$	2.19E-02	8.22E-02	2.34E-02*	2.11E-01*
	$h = 66$	2.15E-02	1.57E-01	2.33E-02*	1.92E-01*
	$h = 132$	2.08E-02	−5.65E-02	2.10E-02*	1.71E-01*
Inds/Off	$h = 22$	2.19E-02	8.85E-02	3.03E-02	1.43E-01
	$h = 66$	2.23E-02	3.53E-02	3.01E-02	1.32E-01
	$h = 132$	2.12E-02	−3.16E-01	2.92E-02	1.15E-01
Industrial	$h = 22$	4.38E-02**	6.14E-02	2.37E-02	1.82E-02
	$h = 66$	4.33E-02**	5.12E-02	2.36E-02	1.39E-02
	$h = 132$	4.32E-02*	−4.13E-01	2.27E-02	8.76E-03
LDG/ Resorts	$h = 22$	4.49E-02*	1.06E-01*	6.88E-02**	7.41E-01**
	$h = 66$	4.48E-02*	6.70E-02	6.78E-02**	7.03E-01**
	$h = 132$	4.43E-02*	−2.45E-01	6.74E-02**	6.36E-01**
Office	$h = 22$	2.99E-02*	6.23E-02	2.53E-02**	2.06E-01**
	$h = 66$	2.95E-02*	8.70E-02	2.52E-02**	1.88E-01**
	$h = 132$	2.89E-02*	−6.70E-02	2.46E-02**	1.73E-01**
Rental	$h = 22$	2.84E-02**	5.35E-02	2.48E-02*	8.51E-02*
	$h = 66$	2.80E-02**	−5.24E-02	2.45E-02*	7.73E-02*
	$h = 132$	2.77E-02**	−2.59E-01	2.34E-02*	6.63E-02*
Residential	$h = 22$	1.71E-02	5.43E-02	1.59E-02	9.26E-02
	$h = 66$	1.67E-02	9.68E-02	1.59E-02	7.85E-02
	$h = 132$	1.65E-02	−3.77E-02	1.62E-02	6.91E-02
Retail	$h = 22$	2.76E-02	5.21E-02	2.41E-02	3.06E-01**
	$h = 66$	2.73E-02	8.77E-02	2.39E-02	2.84E-01**
	$h = 132$	2.78E-02	5.77E-02	2.33E-02	2.60E-01**
Self-Storage	$h = 22$	3.81E-02*	5.80E-02	3.01E-02*	1.02E-01*
	$h = 66$	3.77E-02*	−4.09E-02	2.97E-02*	8.93E-02*
	$h = 132$	3.69E-02*	−3.70E-01	2.99E-02*	7.95E-02*
Specialty	$h = 22$	2.03E-01**	3.67E-02	–	–
	$h = 66$	2.01E-01**	7.47E-02	–	–
	$h = 132$	1.86E-01**	6.18E-02	–	–
Regional REITs					
Developed	$h = 22$	6.70E-03	6.98E-02**	1.26E-02***	8.83E-02**
	$h = 66$	6.51E-03	6.69E-02*	1.25E-02***	8.02E-02**
	$h = 132$	6.42E-03	2.30E-03	1.23E-02***	7.28E-02*
DEV EMEA	$h = 22$	1.33E-02**	–	1.78E-02***	9.75E-02**
	$h = 66$	1.31E-02**	–	1.76E-02***	8.51E-02**
	$h = 132$	1.27E-02**	–	1.67E-02***	8.29E-02**
EM EMEA	$h = 22$	2.62E-02**	–	2.53E-02***	5.11E-02
	$h = 66$	2.57E-02**	–	2.47E-02***	4.71E-02
	$h = 132$	2.55E-02**	–	2.44E-02***	4.33E-02
Emerging	$h = 22$	4.90E-03	–	1.20E-02**	1.04E-01**
	$h = 66$	4.08E-03	–	1.17E-02**	9.51E-02**
	$h = 132$	4.75E-03	–	1.06E-02**	9.68E-02**
Global	$h = 22$	5.16E-03	–	1.04E-02***	8.72E-02*
	$h = 66$	5.00E-03	–	1.03E-02***	8.02E-02*
	$h = 132$	4.90E-03	–	9.37E-03***	7.35E-02*

Note: The figures in each cell are the CW statistics that compare our predictive model with a benchmark AR(1) model. Positive and statistically significant CW statistics indicate a preference for our predictive model over the benchmark model. The ***, ** and * denote 1%, 5% and 10% significance levels, respectively.

A typical mean-variance utility investor would always optimize the available portfolios in contrast to a risk-free asset by carefully allocating shares among investment options, using optimal weight, w_t, defined as

$$w_t = \frac{1}{\gamma}\frac{\theta\widehat{r}_{t+1} + (\theta - 1)\widehat{r}^f_{t+1}}{\theta^2\widehat{\sigma}^2_{t+1}} \tag{3}$$

where γ denotes a risk aversion coefficient; θ represents a leverage ratio that is set to 6 and 8, given that investors often maintain a 10% margin; $\widehat{r}_{t+1}$ represents the REIT returns forecast at time $t+1$; $\widehat{r}^f_{t+1}$ represents a risk-free asset (3-month Treasury bill rate); and $\widehat{\sigma}^2_{t+1}$ represents an estimate of return volatility, obtained as a 30-day moving window of daily returns. The certainty equivalent return for the investor's optimal portfolio allocation is defined in eq. (4)

$$CER = \overline{R}_p - 0.5(1/\gamma)\sigma^2_p \tag{4}$$

where $\overline{R}_p$ is the out-of-sample mean; and σ^2_p is the out-of-sample variance of the portfolio return, defined as $R_p = w\theta(r - r^f) + (1 - w)r^f$. The economic significance is determined by maximizing an objective function of a utility as in eq. (5)

$$\begin{aligned} U(R_p) &= E(R_p) - 0.5(1/\gamma)Var(R_p) \\ &= w\theta(r - r^f) + (1 - w)r^f - 0.5(1/\gamma)w^2\theta^2\sigma^2 \end{aligned} \tag{5}$$

where $Var(R_p) = w^2\theta^2\sigma^2$ gives the variance of the portfolio return, and σ^2 denotes excess return volatility. The contending model is adjudged to have a more favourable economic gain if it yields the highest returns, CER and Sharpe ratio, which is defined as $SR = (R_p - r^f)/\sqrt{Var(R_p)}$; and minimum volatility (see Liu, Tang, & Zhou, 2019).

The previous specification of the computational formula for economic significance does not consider the cost of implementing the portfolio investment strategy. However, the next specification incorporates transaction cost in the computation of the economic significance for the contending models. Drawing from (Callot, Kock, & Medeiros, 2017), the average portfolio turnover for the out-of-sample period is computed as:

$$TO_t = \left|\widehat{w}_t - \widehat{w}_{t-1}^{hold}\right| \tag{6}$$

where $\widehat{w}_{t-1}^{hold} = \widehat{w}_{t-1}\left[(1+r_{t-1})/(1+R_{p,t-1})\right]$ represents the weight of the hold portfolio; and the turnover measures the average change in the portfolio weights. Eq. (6) is suited for a case where a risky asset is compared against a risk-free asset; such that only the transaction cost (c) for the risky asset is required. The adjusted portfolio returns for the risky asset are defined as$R_p^{adjust} = R_p - cTO$; and the corresponding volatility, CER and Sharpe ratio are computed for the adjusted portfolio returns.

Tables 4–6 present the results of the economic gain under the considerations of no transactional cost, 0.5% transactional cost and 1% transactional cost, respectively. Each table displays the mean portfolio returns, volatility, certainty equivalent returns and Sharpe ratios obtained from the contending models – our predictive and benchmark models. We observe that our predictive model yields, in most cases, positive mean portfolio returns, with a characteristic feat of higher returns associated with higher risk. Compared with the benchmark AR (1) model, our predictive model yields higher returns and CER and Sharpe ratio values. Imperatively, the incorporation of gold realized volatility in the predictive model yields improved economic gains than the benchmark AR(1) model when the leverage ratio is set to either 6 or 8 (see results in Table 4). While we find similar feats of economic gains irrespective of the leverage parameters, the returns and economic gains are relatively lower for the leverage ratio set at 6. Overall, the economic analysis of portfolios constructed based on the return forecasts obtained from contending models shows that incorporating gold realized volatility not only yields more precise out-of-sample return forecasts but also yields more utility gains and lends credence to the stance of out-performance revealed by the CW test.

We further consider cases where transactional cost is taken cognizance of, in line with extant literature (see Bollerslev, Patton, & Quaedvlieg, 2018; Brown & Smith, 2011; Fleming, Kirby, & Ostdiek, 2001; Luo, Demirer, Gupta, & Ji, 2022). We set the transaction cost to 0.5% (see results in Table 5) and 1% (see results in Table 6), to ascertain its impact on the returns of the risky asset compared with the risk-free asset. The results in Tables 5 and 6 show the turnover, adjusted returns, volatility, CER and Sharpe ratio. The stances remain unchanged when the cost of implementing a portfolio investment strategy has been factored into the computation of the economic significance of the incorporated predictor variable. In sum, gold realized volatility is a good predictor that can improve the out-of-sample forecast performance of the predictive model and also offer improved economic outcomes for investors.

3.4. Additional results

3.4.1. REIT returns – Stock realized volatility

Here, we consider stock-realized volatility in place of the gold-realized volatility used in the main estimation to ascertain the sensitivity of the model performance to the choice of market-realized volatility. Past studies examining the volatility of the gold and stock markets have produced interesting findings. Iqbal (2017) investigates the hedging potential of gold against adverse movements of stock prices, inflation, and exchange rates in India, Pakistan, and the United States. The paper finds that the evidence of gold hedging stock market risk is not uniformly strong in all market conditions in the three countries. Do, Mcaleer, and Sriboonchitta (2009) has earlier discussed the volatility of emerging and international gold markets and find that gold could be a substitute for commodity and stocks in specific countries, given the

Table 4
Economic Significance (With no Transactional Costs).

	Model	Returns	Volatility	CER	SP	Returns	Volatility	CER	SP
		$\gamma = 3$ *and* $\theta = 6$				$\gamma = 3$ *and* $\theta = 8$			
Sectoral REITs									
Diversified	AR(1)	3.69E-02	2.50E-36	3.69E-02	−2.07E+15	3.59E-02	4.44E-36	3.59E-02	−2.00E+15
	Gold	4.04E-02	5.35E-04	4.01E-02	**1.19E-02**	4.07E-02	9.47E-04	4.04E-02	**1.68E-02**
Healthcare	AR(1)	3.75E-02	2.74E-37	3.75E-02	−4.97E+15	3.68E-02	4.88E-37	3.68E-02	−4.76E+15
	Gold	3.83E-02	9.62E-04	3.79E-02	−5.93E-02	3.78E-02	1.67E-03	3.75E-02	−5.59E-02
Inds/Off	AR(1)	3.65E-02	4.51E-36	3.65E-02	−1.71E+15	3.54E-02	8.00E-36	3.54E-02	−1.66E+15
	Gold	3.59E-02	3.34E-03	3.53E-02	−7.30E-02	3.48E-02	6.41E-03	3.42E-02	−6.69E-02
Industrial	AR(1)	–	–	–	–	–	–	–	–
	Gold	4.19E-02	6.25E-04	4.15E-02	7.13E-02	4.27E-02	1.11E-03	4.23E-02	7.59E-02
LDG/Resorts	AR(1)	3.63E-02	1.78E-35	3.63E-02	−9.08E+14	3.52E-02	3.16E-35	3.52E-02	−8.82E+14
	Gold	4.59E-02	8.30E-04	4.54E-02	**2.00E-01**	4.80E-02	1.47E-03	4.74E-02	**2.04E-01**
Office	AR(1)	3.66E-02	4.49E-36	3.66E-02	−1.68E+15	3.55E-02	7.97E-36	3.55E-02	−1.63E+15
	Gold	3.79E-02	7.36E-04	3.77E-02	−8.20E-02	3.73E-02	1.27E-03	3.71E-02	−7.87E-02
Rental	AR(1)	3.78E-02	9.57E-36	3.78E-02	−7.47E+14	3.72E-02	1.70E-35	3.72E-02	−7.10E+14
	Gold	4.09E-02	2.69E-04	4.08E-02	**4.97E-02**	4.14E-02	4.76E-04	4.12E-02	**5.65E-02**
Residential	AR(1)	3.83E-02	3.91E-35	3.83E-02	−2.89E+14	3.79E-02	6.96E-35	3.79E-02	−2.72E+14
	Gold	4.11E-02	4.82E-04	4.08E-02	**4.38E-02**	4.16E-02	8.54E-04	4.13E-02	**4.89E-02**
Retail	AR(1)	3.66E-02	7.26E-34	3.66E-02	−1.33E+14	3.55E-02	1.29E-33	3.55E-02	−1.28E+14
	Gold	4.78E-02	4.50E-04	4.75E-02	**3.60E-01**	5.05E-02	7.99E-04	5.02E-02	**3.65E-01**
Self Storage	AR(1)	3.92E-02	6.93E-35	3.92E-02	−1.06E+14	3.91E-02	1.23E-34	3.91E-02	−9.31E+13
	Gold	4.14E-02	1.10E-03	4.07E-02	**3.72E-02**	4.19E-02	1.94E-03	4.13E-02	**4.07E-02**
Specialty	AR(1)	1.42E-03	2.51E-37	1.42E-03	−9.37E+14	1.41E-03	4.45E-37	1.41E-03	−7.16E+14
	Gold	1.53E-02	1.98E-03	1.41E-02	**3.02E-01**	1.99E-02	3.53E-03	1.87E-02	**3.04E-01**
Regional REITs									
Developed	AR(1)	3.70E-02	2.44E-36	3.70E-02	−2.00E+15	3.61E-02	4.33E-36	3.61E-02	−1.93E+15
	Gold	3.96E-02	3.50E-04	3.94E-02	−3.07E-02	3.95E-02	6.18E-04	3.93E-02	−2.48E-02
DEV EMEA	AR(1)	3.79E-02	4.32E-36	3.79E-02	−1.07E+15	3.73E-02	7.69E-36	3.73E-02	−1.02E+15
	Gold	4.03E-02	5.25E-04	4.00E-02	**8.58E-03**	4.06E-02	9.28E-04	4.03E-02	**1.39E-02**
EM EMEA	AR(1)	–	–	–	–	–	–	–	–
	Gold	3.98E-02	8.76E-04	3.94E-02	−1.14E-02	3.98E-02	1.54E-03	3.95E-02	−7.42E-03
Emerging	AR(1)	3.69E-02	1.11E−36	3.69E-02	-3.07E+15	3.60E-02	1.97E-36	3.60E-02	−2.96E+15
	Gold	4.00E-02	1.52E-04	3.99E-02	−8.10E-03	4.01E-02	2.70E-04	4.00E-02	2.73E-04
Global	AR(1)	3.80E-02	9.71E-36	3.80E-02	−6.79E+14	3.75E-02	1.73E-35	3.75E-02	−6.43E+14
	Gold	3.97E-02	2.75E-04	3.95E-02	−2.73E-02	3.97E-02	4.85E-04	3.95E-02	−2.06E-02

Table 5
Economic Significance 0.5% Transactional cost.

	Model	TO	Adjusted Returns	Volatility	CER	SP	TO	Adjusted Returns	Volatility	CER	SP
		$\gamma = 3$ *and* $\theta = 6$					$\gamma = 3$ *and* $\theta = 8$				
Sectoral REITs											
Diversified	AR(1)	5.32E-04	3.69E-02	2.50E-36	3.69E-02	−2.02E+15	5.65E-04	3.60E-02	4.44E-36	3.60E-02	−1.96E+15
	Gold	5.98E-03	4.05E-02	5.36E-04	4.02E-02	**1.50E-02**	5.88E-03	4.07E-02	9.47E-04	4.04E-02	**1.91E-02**
Healthcare	AR(1)	4.30E-04	3.76E-02	2.75E-37	3.76E-02	−4.80E+15	4.54E-04	3.69E-02	4.88E-37	3.69E-02	−4.64E+15
	Gold	1.03E-02	3.84E-02	9.62E-04	3.80E-02	−5.73E-02	1.00E-02	3.79E-02	1.67E-03	3.75E-02	−5.43E-02
Inds/Off	AR(1)	5.94E-04	3.66E-02	4.51E-36	3.66E-02	−1.68E+15	6.37E-04	3.55E-02	8.00E-36	3.55E-02	−1.64E+15
	Gold	2.06E-02	3.61E-02	3.34E-03	3.55E-02	−7.00E-02	2.16E-02	3.50E-02	6.41E-03	3.44E-02	−6.40E-02
Industrial	AR(1)	–	–	–	–	–	–	–	–	–	–
	Gold	5.25E-03	4.20E-02	6.25E-04	4.16E-02	**7.36E-02**	5.19E-03	4.27E-02	1.11E-03	4.23E-02	**7.74E-02**
LDG/Resorts	AR(1)	7.25E-04	3.64E-02	1.79E-35	3.64E-02	−8.90E+14	6.46E-04	3.52E-02	3.16E-35	3.52E-02	−8.69E+14
	Gold	4.12E-03	4.59E-02	8.30E-04	4.54E-02	**2.01E-01**	4.10E-03	4.80E-02	1.47E-03	4.75E-02	**2.05E-01**
Office	AR(1)	5.82E-04	3.66E-02	4.49E-36	3.66E-02	−1.65E+15	6.22E-04	3.56E-02	7.97E-36	3.56E-02	−1.60E+15
	Gold	1.05E-02	3.80E-02	7.39E-04	3.77E-02	−7.94E-02	1.02E-02	3.74E-02	1.27E-03	3.71E-02	−7.67E-02
Rental	AR(1)	3.31E-04	3.79E-02	9.57E-36	3.79E-02	−7.18E+14	3.00E-04	3.73E-02	1.70E-35	3.73E-02	−6.89E+14
	Gold	4.27E-03	4.10E-02	2.69E-04	4.09E-02	**5.58E-02**	4.22E-03	4.15E-02	4.76E-04	4.13E-02	**6.11E-02**
Residential	AR(1)	2.98E-04	3.84E-02	3.92E-35	3.84E-02	−2.75E+14	3.17E-04	3.80E-02	6.96E-35	3.80E-02	−2.61E+14
	Gold	5.23E-03	4.12E-02	4.82E-04	4.09E-02	**4.67E-02**	5.16E-03	4.16E-02	8.54E-04	4.13E-02	**5.10E-02**
Retail	AR(1)	2.72E-03	3.66E-02	7.32E-34	3.66E-02	−1.30E+14	2.74E-03	3.56E-02	1.29E-33	3.56E-02	−1.27E+14
	Gold	3.10E-03	4.78E-02	4.50E-04	4.75E-02	**3.61E-01**	3.07E-03	5.05E-02	7.99E-04	5.02E-02	**3.65E-01**
Self Storage	AR(1)	1.68E-04	3.93E-02	6.93E-35	3.93E-02	−9.53E+13	1.85E-04	3.92E-02	1.23E-34	3.92E-02	−8.49E+13
	Gold	6.87E-03	4.14E-02	1.10E-03	4.08E-02	**3.92E-02**	6.75E-03	4.20E-02	1.94E-03	4.14E-02	**4.22E-02**
Specialty	AR(1)	2.54E-03	1.40E-03	2.51E-37	1.40E-03	−9.63E+14	2.54E-03	1.40E-03	4.45E-37	1.40E-03	−7.36E+14
	Gold	4.47E-03	1.53E-02	1.99E-03	1.41E-02	**3.02E-01**	4.41E-03	2.00E-02	3.53E-03	1.87E-02	**3.04E-01**
Regional REITs											
Developed	AR(1)	5.80E-04	3.71E-02	2.44E-36	3.71E-02	−1.95E+15	5.33E-04	3.62E-02	4.33E-36	3.62E-02	−1.89E+15
	Gold	5.32E-03	3.96E-02	3.50E-04	3.95E-02	−2.65E-02	5.24E-03	3.96E-02	6.18E-04	3.94E-02	−2.18E-02
DEV EMEA	AR(1)	3.65E-04	3.80E-02	4.33E-36	3.80E-02	−1.03E+15	3.86E-04	3.74E-02	7.69E-36	3.74E-02	−9.85E+14
	Gold	5.63E-03	4.04E-02	5.26E-04	4.01E-02	**1.29E-02**	5.61E-03	4.06E-02	9.28E-04	4.04E-02	**1.68E-02**
EM EMEA	AR(1)	–	–	–	–	–	–	–	–	–	–
	Gold	7.17E-03	3.99E-02	8.81E-04	3.95E-02	−8.00E-03	7.06E-03	3.99E-02	1.54E-03	3.96E-02	−5.27E-03
Emerging	AR(1)	5.25E-04	3.70E-02	1.11E-36	3.70E-02	−2.99E+15	5.57E-04	3.61E-02	1.97E-36	3.61E-02	−2.91E+15
	Gold	3.13E-03	4.01E-02	1.52E-04	4.00E-02	−8.26E-04	3.09E-03	4.02E-02	2.70E-04	4.01E-02	5.78E-03
Global	AR(1)	3.14E-04	3.81E-02	9.72E-36	3.81E-02	−6.50E+14	3.34E-04	3.75E-02	1.73E-35	3.75E-02	−6.22E+14
	Gold	4.79E-03	3.98E-02	2.75E-04	3.96E-02	−2.21E-02	4.73E-03	3.98E-02	4.85E-04	3.96E-02	−1.68E-02

scope of their study. The arising implication from here is that gold market return and the stock market return in many instances, countries and periods do in fact, move in the same direction where volatility in either will always create a possible ground for hedging between the two assets. Another recent finding by Ma, Sun, Zhai, and Jin (2021) provides evidence that suggest that gold can be used as hedge in a time where stock market is highly volatile. Again, a further analysis by Triki and Maatoug (2021) for US stock market provides evidence that the hedging ability of both assets are period specific. In time of turmoil the hedging ability is more pronounced than in tranquil period. Similar stance if also upheld for India, US and UK in the study by Ghazali, Lean, and Bahari (2020). Therefore, using stock market volatility in place of the gold market volatility for robustness test is justified. The two assets indeed share common features that can be leveraged upon for portfolio diversification.

A similar series of estimations as with the main estimation is conducted using the stock realized volatility proxy. REIT returns are expected to respond positively to stock market volatility, such that when crises erupt in the latter, investors can seek refuge in the former. Consequently, we estimate the in-sample predictability of stocks realized volatility for REITs of different categorizations (sectoral and regional). The in-sample predictability results are presented in Table 7, while the forecast evaluation results are presented in Tables 8a (in-sample period) and 8b (out-of-sample periods). On the in-sample predictability, we find a larger proportion of similarities with the positive effect of gold realized volatility on REITs in the main estimation section. The exception here is that there appears to be no statistically significant negative nexus under the pre-GFC period. However, homogeneous nexus across sub-sample periods are evidenced in Diversified Lodging/Resorts, Office, and Retail REITs sectors; and Developed region. Summarily, heightened volatility in the stock market tends to yield increased gains for REIT investors, irrespective of the sector or region. (See Table 8b).

Furthermore, the out-performance of our predictive model in terms of forecast precision in the in-sample period is not different from what was observed with the gold realized volatility stance. The forecast precision of our predictive model overwhelmingly surpasses that of the benchmark model. For the out-of-sample period, while there are several instances of no marked difference between the precision of the contending models, there are more cases where our predictive model performed better than the benchmark model. Imperatively, including lags of stock realized volatility improves the predictability and forecast precision in the in-sample period; however, it only does so relatively in the out-of-sample period. The out-of-sample forecast evaluation result may be sensitive to the choice of sub-sample periods and the realized volatility employed. Still, in more cases, our predictive model performed better.

3.4.2. Accounting for additional predictors (macroeconomic variables)

Here, we account for three macroeconomic fundamentals while assessing the REIT returns – gold realized volatility nexus across the defined sub-periods. This is by way of ascertaining the stability/sensitivity, or otherwise, of our results when we control for some macroeconomic fundamentals. The macroeconomic variables here considered are inflation rate (10-year breakeven inflation rate), exchange rate (USD to Pounds Spot Exchange rate) and interest rate (3-month treasury bill rate), all sourced from the FRED Louis database. Essentially, three new model constructs are specified given the incorporated macroeconomic

Table 6
Economic Significance 1% Transactional cost.

	Model	TO	Adjusted Returns	Volatility	CER	SP	TO	Adjusted Returns	Volatility	CER	SP
		$\gamma = 3$ *and* $\theta = 6$					$\gamma = 3$ *and* $\theta = 8$				
Sectoral REITs											
Diversified	AR(1)	5.32E-04	3.69E-02	2.50E-36	3.69E-02	−2.02E+15	5.65E-04	3.60E-02	4.44E-36	3.60E-02	−1.97E+15
	Gold	5.98E-03	4.05E-02	5.36E-04	4.02E-02	**1.37E-02**	5.88E-03	4.07E-02	9.47E-04	4.04E-02	**1.81E-02**
Healthcare	AR(1)	4.30E-04	3.76E-02	2.75E-37	3.76E-02	−4.81E+15	4.54E-04	3.69E-02	4.88E-37	3.69E-02	−4.64E+15
	Gold	1.03E-02	3.83E-02	9.62E-04	3.79E-02	−5.90E-02	1.00E-02	3.79E-02	1.67E-03	3.75E-02	−5.55E-02
Inds/Off	AR(1)	5.94E-04	3.66E-02	4.51E-36	3.66E-02	−1.68E+15	6.37E-04	3.55E-02	8.00E-36	3.55E-02	−1.64E+15
	Gold	2.06E-02	3.60E-02	3.34E-03	3.54E-02	−7.18E-02	2.16E-02	3.49E-02	6.41E-03	3.43E-02	−6.54E-02
Industrial	AR(1)	–	–	–	–	–	–	–	–	–	–
	Gold	5.25E-03	4.19E-02	6.25E-04	4.16E-02	**7.26E-02**	5.19E-03	4.27E-02	1.11E-03	4.23E-02	**7.66E-02**
LDG/Resorts	AR(1)	7.25E-04	3.64E-02	1.79E-35	3.64E-02	−8.91E+14	6.46E-04	3.52E-02	3.16E-35	3.52E-02	−8.70E+14
	Gold	4.12E-03	4.59E-02	8.30E-04	4.54E-02	**2.01E-01**	4.10E-03	4.80E-02	1.47E-03	4.74E-02	**2.04E-01**
Office	AR(1)	5.82E-04	3.66E-02	4.49E-36	3.66E-02	−1.65E+15	6.22E-04	3.56E-02	7.97E-36	3.56E-02	−1.60E+15
	Gold	1.05E-02	3.79E-02	7.39E-04	3.77E-02	−8.13E-02	1.02E-02	3.74E-02	1.27E-03	3.71E-02	−7.81E-02
Rental	AR(1)	3.31E-04	3.79E-02	9.57E-36	3.79E-02	−7.19E+14	3.00E-04	3.73E-02	1.70E-35	3.73E-02	−6.90E+14
	Gold	4.27E-03	4.10E-02	2.69E-04	4.09E-02	**5.45E-02**	4.22E-03	4.14E-02	4.76E-04	4.13E-02	**6.01E-02**
Residential	AR(1)	2.98E-04	3.84E-02	3.92E-35	3.84E-02	−2.75E+14	3.17E-04	3.80E-02	6.96E-35	3.80E-02	−2.61E+14
	Gold	5.23E-03	4.11E-02	4.82E-04	4.08E-02	**4.55E-02**	5.16E-03	4.16E-02	8.54E-04	4.13E-02	**5.01E-02**
Retail	AR(1)	2.72E-03	3.66E-02	7.32E-34	3.66E-02	−1.31E+14	2.74E-03	3.56E-02	1.29E-33	3.56E-02	−1.27E+14
	Gold	3.10E-03	4.78E-02	4.50E-04	4.75E-02	**3.60E-01**	3.07E-03	5.04E-02	7.99E-04	5.01E-02	**3.64E-01**
Self Storage	AR(1)	1.68E-04	3.93E-02	6.93E-35	3.93E-02	−9.54E+13	1.85E-04	3.92E-02	1.23E-34	3.92E-02	−8.49E+13
	Gold	6.87E-03	4.14E-02	1.10E-03	4.08E-02	**3.81E-02**	6.75E-03	4.20E-02	1.94E-03	4.13E-02	**4.15E-02**
Specialty	AR(1)	2.54E-03	1.39E-03	2.51E-37	1.39E-03	−9.88E+14	2.54E-03	1.38E-03	4.45E-37	1.38E-03	−7.55E+14
	Gold	4.47E-03	1.53E-02	1.99E-03	1.41E-02	3.01E-01	4.41E-03	1.99E-02	3.53E-03	1.87E-02	3.04E-01
Regional REITs											
Developed	AR(1)	5.80E-04	3.71E-02	2.44E-36	3.71E-02	−1.95E+15	5.33E-04	3.62E-02	4.33E-36	3.62E-02	−1.89E+15
	Gold	5.32E-03	3.96E-02	3.50E-04	3.94E-02	−2.79E-02	5.24E-03	3.96E-02	6.18E-04	3.94E-02	−2.29E-02
DEV EMEA	AR(1)	3.65E-04	3.80E-02	4.33E-36	3.80E-02	−1.03E+15	3.86E-04	3.74E-02	7.69E-36	3.74E-02	−9.86E+14
	Gold	5.63E-03	4.04E-02	5.26E-04	4.01E-02	**1.17E-02**	5.61E-03	4.06E-02	9.28E-04	4.03E-02	**1.59E-02**
EM EMEA	AR(1)	–	–	–	–	–	–	–	–	–	–
	Gold	7.17E-03	3.99E-02	8.81E-04	3.95E-02	−9.21E-03	7.06E-03	3.99E-02	1.54E-03	3.95E-02	−6.17E-03
Emerging	AR(1)	5.25E-04	3.70E-02	1.11E-36	3.70E-02	−2.99E+15	5.57E-04	3.61E-02	1.97E-36	3.61E-02	−2.91E+15
	Gold	3.13E-03	4.01E-02	1.52E-04	4.00E-02	−2.10E-03	3.09E-03	4.02E-02	2.70E-04	4.01E-02	4.84E-03
Global	AR(1)	3.14E-04	3.81E-02	9.72E-36	3.81E-02	−6.50E+14	3.34E-04	3.75E-02	1.73E-35	3.75E-02	−6.22E+14
	Gold	4.79E-03	3.97E-02	2.75E-04	3.96E-02	−2.35E-02	4.73E-03	3.97E-02	4.85E-04	3.96E-02	−1.79E-02

Table 7
In-Sample Predictability (REITs Return – Stock RV nexus).

	Full	Pre-GFC	GFC-Pre-COVID	COVID
Sectoral REITs				
Diversified	1.83E-03*** [2.57E-04]	3.26E-03*** [1.00E-03]	1.70E-03*** [1.75E-04]	7.00E-03*** [1.14E-03]
Healthcare	2.34E-03*** [1.52E-04]	−6.00E-04 [8.90E-04]	3.43E-03*** [2.92E-04]	2.99E-03*** [2.03E-04]
Inds/Off	2.64E-03*** [1.21E-04]	−2.30E-04 [1.82E-03]	3.08E-03*** [5.12E-05]	5.36E-03*** [6.53E-04]
Industrial	1.60E-03*** [1.36E-04]	1.28E-03 [1.53E-03]	6.23E-03*** [6.62E-04]	2.04E-03*** [2.62E-04]
LDG/ Resorts	1.12E-03*** [1.22E-04]	7.93E-03*** [1.26E-03]	1.46E-03*** [1.92E-04]	5.67E-03*** [5.05E-04]
Office	1.98E-03*** [1.68E-04]	4.75E-03*** [1.19E-03]	3.06E-03*** [1.11E-04]	3.68E-03*** [6.02E-04]
Rental	1.88E-03*** [1.80E-04]	1.25E-03 [8.32E-04]	3.19E-03*** [9.33E-05]	2.58E-03*** [5.98E-04]
Residential	6.36E-04*** [9.57E-05]	−8.64E-04 [8.51E-04]	3.93E-03*** [4.10E-04]	3.29E-03*** [5.75E-04]
Retail	3.55E-03*** [1.94E-04]	4.47E-03*** [8.68E-04]	4.61E-03*** [1.31E-04]	2.36E-03*** [4.05E-04]
Self-Storage	5.08E-04*** [1.33E-04]	2.90E-03** [1.31E-03]	2.99E-03*** [2.44E-04]	7.05E-04 [7.08E-04]
Specialty	−2.70E-04 [4.13E-04]	1.90E-03** [8.27E-04]	–	–
Regional REITs				
Developed	1.28E-03*** [1.91E-04]	1.75E-03*** [5.46E-04]	2.93E-03*** [9.16E-05]	4.46E-03*** [5.82E-04]
DEV EMEA	2.10E-03*** [2.56E-04]	–	1.85E-03*** [8.83E-05]	2.24E-03*** [4.89E-04]
EM EMEA	1.43E-03*** [1.42E-04]	−4.74E-04 [2.79E-03]	3.12E-03*** [1.15E-04]	1.63E-03*** [4.02E-04]
Emerging	1.28E-03*** [1.36E-04]	–	5.20E-03*** [5.75E-04]	2.40E-03*** [3.27E-04]
Global	2.14E-03*** [1.36E-04]	–	3.69E-03*** [2.73E-05]	4.49E-03*** [7.67E-04]

Note: The figures in each cell are the sum of the five lags of gold realized volatility and their corresponding standard errors, with the Wald-determined statistical significance denoted as ***, ** and * for 1%, 5% and 10% significance levels, respectively. The cell with "-" indicates cases where there are not enough observation points to estimate our predictive model.

Table 8a
Clark and West In-Sample Forecast Evaluation (REITs – Stock nexus).

	Full	Pre-GFC	GFC-Pre-COVID	COVID
Sectoral REITs				
Diversified	6.96E-02***	3.60E-01***	4.35E-03***	2.28E-01***
Healthcare	5.83E-02***	2.02E-01***	1.15E-02***	5.71E-01***
Inds/Off	8.04E-02***	2.10E-01***	1.85E-02***	9.39E-01***
Industrial	7.41E-02***	2.22E-01***	3.01E-02***	3.15E-01***
LDG/ Resorts	9.88E-02***	3.10E-01***	7.10E-02***	5.44E-01***
Office	4.81E-02***	3.75E-01***	1.82E-02***	1.74E-01***
Rental	3.85E-02***	2.98E-01***	1.03E-02***	1.81E-01***
Residential	2.68E-02***	2.22E-01***	3.40E-04***	1.41E-01***
Retail	1.01E-02***	2.03E-01***	1.03E-02***	3.87E-01***
Self-Storage	3.54E-02***	1.18E-01***	1.24E-02***	1.57E-01***
Specialty	3.04E-01***	2.37E-01***		
Regional REITs				
Developed	4.47E-02***	2.12E-01***	1.35E-02***	2.14E-01***
DEV EMEA	1.12E-01***	–	3.65E-02***	1.45E-01***
EM EMEA	9.66E-02***	4.22E+00***	4.28E-02***	1.12E-01***
Emerging	3.97E-02***	–	1.56E-02***	6.05E-02***
Global	6.03E-02***	–	2.00E-02***	2.24E-01***

Note: The figures in each cell are the CW statistics that compare our predictive model with a benchmark AR(1) model. Positive and statistically significant CW statistics indicate a preference for our predictive model over the benchmark model. The ***, ** and * denote 1%, 5% and 10% significance levels, respectively.

variable. Model A comprises gold realized volatility and inflation rate; Model B comprises gold realized volatility and exchange rate; while Model C comprises gold realized volatility and interest rate as predictors. Inflation is expected to have a positive impact on REIT returns since real estate values tend to increase when general prices increase, thus yielding higher returns for investors of REITs. However, if the prevailing interest rate is also increased, the REIT returns – inflation nexus may be negative, given that the performance of REITs is impeded by the reduction of disposable income, which is an immediate fall-out of general low prices. The higher interest rate tends to exert a negative impact on REIT returns, given that the borrowing cost of real estate investment is increased, thus reducing investment capability and, subsequently, lower returns for investors. The exchange rate may be positive (negative) if the local currency is stronger (weaker) than the REIT reporting currency.

From the foregoing, we present the results of the in-sample predictability and the out-of-sample forecast evaluation in Tables A1 and A2 in the Appendix. The presentation follows the pattern as with the main estimation. Gold realized volatility maintains a positive nexus with REIT returns even when we have controlled for some macroeconomic fundamentals, and this is consistent across the sub-period categorization (except for the pre-GFC period where a sizable number of negative relationships were observed). The positive nexus is further confirmation that the higher the volatility in the gold market, the more the gains for a REIT investor. The REIT returns – inflation rate nexus are mixed (positive and negative); REIT returns – exchange rate nexus are mostly positive (except for the Pre-GFC period); and REIT returns – interest rate nexus are mostly negatively (except for the COVID period). The incorporation of the macroeconomic fundamentals tends to improve the out-of-sample forecasts over the benchmark model as shown in Table A2 in the Appendix. Imperatively, controlling for some macroeconomic fundamentals does improve the forecast performance of the model both in the in-sample as well as the out-of-sample period.

4. Conclusion

The issue relating to gold and REITs has not been thoroughly investigated in the literature, and this accounts for our curiosity to evaluate the connection between a volatile gold market condition and REIT returns in the global context. For the region categorization, we consider 11 regions, which range from diversified REITs, industrial, health, specialty, and others, while we equally pay attention to 5 regions

Table 8b
Clark and West Out-of-Sample Forecast Evaluation (REITs – Stock nexus).

		Full	Pre-GFC	GFC-Pre-COVID	COVID
Sectoral REITs					
	$h = 22$	6.92E-02	2.62E-01	4.45E-03	2.19E-01
Diversified	$h = 66$	6.85E-02	−2.95E-02	4.36E-03	2.03E-01
	$h = 132$	6.58E-02	1.60E+00	1.40E-02	1.72E-01
	$h = 22$	5.81E-02	1.59E-01	1.14E-02	5.50E-01
Healthcare	$h = 66$	5.75E-02	−1.22E-01	1.13E-02	5.12E-01
	$h = 132$	5.47E-02	1.11E+00	1.32E-02	4.36E-01
	$h = 22$	7.90E-02	1.63E-01	1.85E-02	8.91E-01
Inds/Off	$h = 66$	8.06E-02	7.90E-02	1.84E-02	8.33E-01
	$h = 132$	7.60E-02	−1.27E+00	1.84E-02	7.44E-01
	$h = 22$	7.40E-02	1.77E-01	3.01E-02	3.04E-01
Industrial	$h = 66$	7.39E-02	4.81E-01	2.96E-02	2.83E-01
	$h = 132$	6.88E-02	1.42E-01	4.20E-02	2.30E-01
	$h = 22$	9.80E-02	2.16E-01	7.06E-02	5.30E-01
LDG/Resorts	$h = 66$	9.86E-02	−1.58E-01	6.91E-02	4.89E-01
	$h = 132$	9.40E-02	4.32E-01	9.09E-02	4.50E-01
	$h = 22$	4.71E-02	2.91E-01	1.82E-02	1.69E-01
Office	$h = 66$	4.75E-02	5.02E-01	1.80E-02	1.53E-01
	$h = 132$	4.46E-02	2.15E+00	2.21E-02	1.32E-01
	$h = 22$	3.85E-02	2.65E-01	1.02E-02	1.79E-01
Rental	$h = 66$	3.84E-02	3.00E-01	9.97E-03	1.64E-01
	$h = 132$	3.63E-02	7.47E-01	1.18E-02	1.37E-01
	$h = 22$	2.65E-02	2.46E-01	3.14E-04	1.37E-01
Residential	$h = 66$	2.64E-02	4.81E-01	3.82E-04	1.28E-01
	$h = 132$	2.39E-02	1.79E+00	2.52E-03	1.01E-01
	$h = 22$	1.12E-02	1.57E-01	1.03E-02	1.86E-01
Retail	$h = 66$	9.79E-03	2.68E-02	1.01E-02	1.68E-01
	$h = 132$	1.07E-02	1.71E+00	1.23E-02	1.56E-01
	$h = 22$	3.51E-02	7.35E-02	1.22E-02	1.56E-01
Self Storage	$h = 66$	3.50E-02	2.01E-01	1.17E-02	1.41E-01
	$h = 132$	3.31E-02	4.91E-01	1.56E-02	1.12E-01
	$h = 22$	2.89E-01	1.90E-01*		
Specialty	$h = 66$	2.69E-01	3.16E-01		
	$h = 132$	2.40E-01	3.62E-01		
Regional REITs					
	$h = 22$	4.45E-02	1.98E-01*	1.34E-02	2.10E-01
Developed	$h = 66$	4.41E-02	−9.42E-03**	1.31E-02	1.86E-01
	$h = 132$	4.22E-02	−1.52E+00	2.04E-02	1.69E-01
	$h = 22$	1.11E-01**	–	3.67E-02*	1.46E-01
DEV EMEA	$h = 66$	1.09E-01**	–	3.58E-02*	1.19E-01
	$h = 132$	1.07E-01**	–	5.21E-02*	1.09E-01
	$h = 22$	9.62E-02**	4.22E+00**	4.27E-02***	1.09E-01
EM EMEA	$h = 66$	9.51E-02**	4.22E+00**	4.16E-02***	1.01E-01
	$h = 132$	9.21E-02**	4.22E+00**	4.95E-02***	8.84E-02
	$h = 22$	3.85E-02*	–	1.56E-02***	5.61E-02
Emerging	$h = 66$	3.74E-02*	–	1.54E-02***	5.11E-02
	$h = 132$	3.60E-02*	–	1.41E-02***	4.92E-02
	$h = 22$	5.97E-02*	–	1.99E-02***	2.18E-01
Global	$h = 66$	5.93E-02*	–	1.93E-02***	1.93E-01
	$h = 132$	5.55E-02*	–	2.94E-02***	1.75E-01

Note: The figures in each cell are the CW statistics that compare our predictive model with a benchmark AR(1) model. Positive and statistically significant CW statistics indicate a preference for our predictive model over the benchmark model. The ***, ** and * denote 1%, 5% and 10% significance levels, respectively.

that include developed, emerging and developing regions. Aside the fact that previous studies have not emphasized this area, our consideration of various sectors and regions makes the findings more plausible. For holistic analysis, we motivate our analysis by using Westerlund and Narayan's autoregressive approach, where in-sample predictability is used alongside out-of-sample forecast evaluation to test the performance of the former. This approach is very helpful for having inbuilt power to deal with a possible inherent issues related to heteroscedasticity, autocorrelation and persistence problems. These particular problems are not unexpected for the data series in the case of this study. In the same instance, we sectionalize our evaluation by accounting for full sample analysis, pre-GFC, GFC to pre-COVID and COVID-19 era and beyond, where it summarily translates to tranquil and turbulent periods. As a way to ensure robustness, we use stock market volatility in place of gold market volatility, which, in a way, provides a basis to buy confidence for our evaluation.

Our in-sample estimation in the full sample indicates that when the condition in the gold market is volatile, investing in REITs will provide higher gains for investors. However, such a condition does not hold under various episodes considered. In the pre-GFC, the predictability of REIT returns for gold market volatility is validated to be sector-specific. While investing in REITs becomes profitable when the condition in the gold market is volatile for some REIT sectors, it is otherwise for others. As for the region under this era, the study is limited to only a region due to the unavailable data range for the period. For this region, the hedging ability of REITs for gold is inconsequential. In the period of the financial crisis up to the COVID era and beyond, the safe haven ability of REITs for gold is upheld overall. By implication, the inherent feature of the gold market condition to be highly volatile will consistently contribute to higher gains for investing in REITs where the gain is rather homogenous across sectors and regions. To further uphold the outcome of our in-sample estimation, the out-of-sample forecast evaluation of Clark and West (2007) is later adopted. The outcome suggests that the benchmark model is preferred. A similar effort is put forth by partitioning the forecast evaluation into 22 days, 66 days and 122 days, respectively, representing 1, 3 and 6 months. Many of the outcomes are also in support of the baseline findings.

For sensitivity analysis, gold-market volatility is replaced by stock-market volatility. The outcome from this model supports the findings of our earlier analysis based on gold market volatility. Besides using in-sample estimation, the out-of-sample forecast evaluation is further considered where the outcome aligns with baseline results. We later account for the economic significance of our overall investigations. Thus, gold investors must pay adequate attention to the condition of the market to know when not to invest where REITs stand as a major contender. In particular, investors can use REITs as a safe haven for gold during a crisis but should also be wary of steps to take when the market is not stressed. In such a time, investment should be guided using further information on REITs by sector.

Table A1
In-Sample Predictability Results (Models with macroeconomic variables).

Sectors	Model A		Model B		Model C	
	Gold Realized Vol.	Inflation	Gold Realized Vol.	Exchange Rate	Gold Realized Vol.	Interest Rate
Full Sample						
Diversified	5.26E-04***[2.83E-05]	7.88E-04[3.53E-03]	9.28E-04***[1.26E-04]	1.61E-01***[9.37E-03]	8.71E-04***[1.05E-04]	−5.94E-03***[1.37E-03]
Healthcare	2.18E-03***[1.13E-04]	2.69E-02***[5.30E-03]	1.95E-03***[5.22E-05]	−6.78E-02***[6.59E-03]	−8.91E-04***[2.05E-04]	−2.15E-02***[9.69E-04]
Inds/Off	2.86E-03***[2.34E-04]	−6.19E-02***[4.96E-03]	3.30E-03***[1.81E-04]	−1.93E-01***[7.72E-03]	2.33E-03***[1.63E-04]	−3.48E-02***[1.22E-03]
Industrial	1.60E-03***[1.40E-04]	−5.98E-02***[6.18E-03]	2.71E-03***[2.23E-04]	−6.87E-02***[1.30E-02]	3.49E-03***[2.96E-04]	2.36E-02***[2.50E-03]
LDG/ Resorts	3.47E-03***[1.68E-04]	6.44E-02***[9.56E-03]	3.50E-03***[1.61E-04]	1.46E-01***[1.03E-02]	2.74E-03***[6.49E-05]	−1.17E-02***[8.49E-04]
Office	1.30E-03***[2.00E-04]	−3.14E-03[6.87E-03]	1.04E-03***[1.66E-04]	1.69E-01***[9.73E-03]	1.36E-03***[1.48E-04]	−1.40E-02***[1.37E-03]
Rental	2.53E-03***[1.46E-04]	−1.29E-02**[6.27E-03]	2.66E-03***[1.33E-04]	1.21E-01***[8.23E-03]	3.09E-03***[1.38E-04]	−3.00E-03***[8.73E-04]
Residential	1.63E-03***[1.52E-04]	−7.81E-03***[2.85E-03]	5.20E-04***[1.87E-04]	9.26E-02***[1.57E-02]	1.25E-03***[1.56E-04]	−3.07E-04[1.29E-03]
Retail	2.57E-03***[8.03E-05]	1.28E-02***[3.20E-03]	2.08E-03***[6.33E-05]	2.94E-01***[1.04E-02]	2.47E-03***[1.30E-04]	−1.44E-02***[1.85E-03]
Self-Storage	2.32E-03***[1.16E-04]	7.94E-02***[4.21E-03]	2.87E-03***[5.91E-05]	−1.16E-02[8.01E-03]	2.09E-03***[1.13E-04]	−5.17E-02***[1.08E-03]
Specialty	1.23E-03**[5.94E-04]	−1.87E-01***[3.12E-02]	2.00E-03***[6.65E-04]	2.47E-01[1.79E-01]	−4.96E-03***[5.24E-04]	−8.06E-02***[8.43E-03]
Pre-GFC						
Diversified	−1.51E-03[1.12E-03]	−6.33E-01***[1.99E-01]	3.92E-03**[1.71E-03]	−1.79E+00***[4.08E-01]	−1.08E-02***[9.65E-04]	−2.29E-01***[2.14E-02]
Healthcare	3.99E-03***[1.01E-03]	−1.42E-01***[2.89E-02]	6.12E-03***[1.70E-03]	7.46E-01[4.95E-01]	−3.41E-03**[1.40E-03]	−1.30E-01***[1.24E-02]
Inds/Off	2.23E-03**[9.03E-04]	−3.48E-02[1.02E-01]	8.24E-04[7.85E-04]	−2.20E+00***[2.82E-01]	−8.19E-03***[4.64E-04]	−2.07E-01***[8.76E-03]
Industrial	−7.23E-03***[6.03E-04]	−8.54E-01***[1.05E-01]	2.47E-04[1.56E-03]	2.81E-01[4.99E-01]	−5.60E-03[3.45E-03]	−1.06E-01***[2.40E-02]
LDG/ Resorts	−3.00E-04[1.20E-03]	−6.96E-01***[1.16E-01]	−3.37E-03***[1.17E-03]	−2.57E+00***[4.17E-01]	−5.34E-03***[1.12E-03]	−6.73E-02***[1.47E-02]
Office	2.10E-03**[8.51E-04]	1.43E-03[6.43E-02]	−1.29E-03[1.02E-03]	−3.64E-01*[2.20E-01]	−7.82E-03***[5.17E-04]	−1.95E-01***[1.56E-02]
Rental	2.50E-03[1.70E-03]	−1.19E-01[1.01E-01]	−1.07E-04[8.21E-04]	−1.39E+00***[1.84E-01]	−5.04E-03***[8.14E-04]	−1.82E-01***[1.74E-02]

(continued on next page)

Table A1 (*continued*)

Sectors	Model A		Model B		Model C	
	Gold Realized Vol.	Inflation	Gold Realized Vol.	Exchange Rate	Gold Realized Vol.	Interest Rate
Residential	2.44E-03***[8.02E-04]	2.42E-02[8.35E-02]	−1.05E-03[1.01E-03]	−6.71E-01**[2.67E-01]	−9.37E-03***[1.14E-03]	−2.11E-01***[1.84E-02]
Retail	−8.31E-04[1.02E-03]	−5.81E-01***[1.12E-01]	3.48E-03**[1.61E-03]	1.34E-01[3.97E-01]	−7.16E-03***[1.27E-03]	−1.50E-01***[1.59E-02]
Self-Storage	5.62E-03***[9.60E-04]	−2.60E-01**[1.19E-01]	4.00E-03***[1.41E-03]	−1.29E+00***[3.93E-01]	1.17E-04[1.31E-03]	−2.13E-01***[1.81E-02]
Specialty	1.87E-06[1.20E-03]	−1.09E-01*[6.55E-02]	2.31E-03*[1.18E-03]	1.09E-01[2.19E-01]	−9.28E-03***[9.53E-04]	−1.74E-01***[1.46E-02]
Post-GFC – Pre-COVID						
Diversified	6.74E-04***[9.55E-05]	4.47E-03[2.88E-03]	2.64E-04**[1.03E-04]	8.58E-02***[1.09E-02]	9.26E-04***[2.38E-04]	−3.85E-03*[2.15E-03]
Healthcare	2.22E-03***[2.81E-04]	7.66E-02***[8.34E-03]	1.58E-03***[2.40E-04]	2.51E-02***[8.10E-03]	2.49E-03***[2.83E-04]	−1.01E-03[9.70E-04]
Inds/Off	2.44E-03***[8.41E-05]	−7.40E-03[5.35E-03]	3.14E-03***[2.36E-04]	−1.48E-02[1.01E-02]	2.34E-03***[3.64E-04]	−2.46E-02***[1.92E-03]
Industrial	2.24E-03***[1.46E-04]	−6.25E-02***[4.62E-03]	2.30E-03***[2.36E-04]	−1.77E-01***[1.69E-02]	3.39E-03***[3.06E-04]	3.40E-02***[2.34E-03]
LDG/ Resorts	3.15E-03***[1.78E-04]	1.15E-01***[4.65E-03]	2.48E-03***[1.98E-04]	2.08E-02[2.07E-02]	3.68E-03***[2.56E-04]	−1.70E-03[2.13E-03]
Office	1.26E-03***[1.92E-04]	−1.96E-02***[4.85E-03]	1.97E-03***[2.63E-04]	5.88E-02***[1.93E-02]	8.34E-04***[1.51E-04]	−1.11E-02**[5.02E-03]
Rental	2.93E-03***[2.41E-04]	4.24E-04[1.00E-02]	2.73E-03***[3.14E-04]	1.13E-01***[1.14E-02]	3.51E-03***[2.89E-04]	1.84E-02***[3.58E-03]
Residential	1.56E-03***[2.63E-04]	−1.24E-02**[5.48E-03]	1.52E-03***[2.60E-04]	−1.37E-02*[8.24E-03]	1.03E-03***[1.69E-04]	1.01E-02***[1.81E-03]
Retail	2.97E-03***[1.46E-04]	7.44E-02***[6.64E-03]	2.14E-03***[1.35E-04]	2.19E-01***[7.00E-03]	2.53E-03***[2.10E-04]	−1.44E-02***[1.93E-03]
Self-Storage	2.59E-03***[1.25E-04]	6.74E-02***[7.25E-03]	2.11E-03***[1.08E-04]	1.95E-01***[5.74E-03]	3.06E-03***[1.21E-04]	−3.80E-03***[8.96E-04]
Specialty	–	–	–	–	–	–
COVID						
Diversified	4.65E-04[8.42E-04]	1.21E-02[2.17E-02]	6.34E-03***[1.13E-03]	5.46E-01***[1.16E-01]	5.13E-03***[5.04E-04]	1.02E-02***[3.87E-03]
Healthcare	1.03E-02***[5.23E-04]	1.24E-02[2.44E-02]	9.65E-03***[6.19E-04]	7.59E-01***[1.31E-01]	1.56E-02***[1.10E-03]	2.78E-02***[7.18E-03]
Inds/Off	4.01E-03***[1.25E-03]	−2.62E-01***[2.50E-02]	6.36E-03***[7.57E-04]	−4.30E-01***[9.05E-02]	6.93E-03***[4.72E-04]	5.93E-02***[3.17E-03]
Industrial	3.09E-03***[6.95E-04]	2.62E-01***[4.57E-02]	4.15E-03***[5.75E-04]	7.60E-01***[8.59E-02]	2.09E-03***[3.11E-04]	4.78E-02***[8.20E-03]
LDG/ Resorts	1.22E-02***[2.81E-03]	−4.79E-01***[4.20E-02]	6.31E-03***[4.50E-04]	−1.03E-01[1.26E-01]	7.14E-03***[4.16E-04]	3.09E-02***[7.00E-03]
Office	4.70E-03***[1.55E-03]	−2.29E-01***[3.38E-02]	5.33E-03***[8.25E-04]	6.92E-01***[1.37E-01]	6.77E-03***[1.02E-03]	8.89E-03*[5.26E-03]
Rental	9.54E-03***[8.71E-04]	−4.29E-02*[2.59E-02]	9.21E-03***[1.25E-03]	9.65E-01***[7.35E-02]	5.60E-03***[4.51E-04]	1.32E-02[8.14E-03]
Residential	7.56E-03***[1.03E-03]	−5.95E-02*[3.14E-02]	7.05E-03***[8.01E-04]	9.46E-01***[1.00E-01]	7.61E-03***[1.01E-03]	1.63E-02[1.30E-02]
Retail	8.69E-03***[1.55E-03]	−3.02E-01***[6.57E-03]	7.55E-03***[1.21E-03]	2.12E-01[1.76E-01]	7.33E-03***[6.59E-04]	6.91E-03***[1.96E-03]
Self-Storage	2.30E-03***[3.02E-04]	8.04E-03[1.44E-02]	2.72E-03***[3.67E-04]	9.95E-01***[1.48E-01]	1.33E-03***[2.91E-04]	8.43E-03[7.26E-03]
Specialty	–	–	–	–	–	–

Note: The figures in each cell are the sum of the five lags of gold realized volatility and three macroeconomic variables (inflation, exchange rate and interest rate); their corresponding standard errors are in square brackets, with the Wald-determined statistical significance denoted as ***, ** and * for 1%, 5% and 10% significance levels, respectively. The cell with "-" indicates cases where there are not enough observation points to estimate our predictive model.

Table A2
Clark and West Out-of-Sample Forecast Evaluation (Models with macroeconomic variables).

Sectors	Model A				Model B				Model C			
	In-Sample	Out-of-Sample			In-Sample	Out-of-Sample			In-Sample	Out-of-Sample		
		$h = 22$	$h = 66$	$h = 132$		$h = 22$	$h = 66$	$h = 132$		$h = 22$	$h = 66$	$h = 132$
Full Sample												
Diversified	0.2815***	0.2798***	0.2791***	0.2774***	0.1558***	0.1551***	0.158***	0.1589***	0.0392**	0.0388**	0.0384**	0.0377**
Healthcare	0.1209***	0.1201***	0.1189***	0.1174***	0.1078***	0.1073***	0.1098***	0.1107***	0.0232	0.0232	0.0234	0.0219
Inds/Off	0.5208***	0.5186***	0.5182***	0.3383***	0.1947***	0.1946***	0.2004***	0.1989***	0.132***	0.132***	0.0406	0.0375
Industrial	0.3575***	0.3554***	0.3528***	0.349***	0.2006***	0.1994***	0.203***	0.206***	0.1288***	0.1276***	0.0523**	0.0526**
LDG/Resorts	0.814***	0.8105***	0.8089***	0.8036***	0.3351***	0.335***	0.3112***	0.3147***	0.0853***	0.0842***	0.0852***	0.0833***
Office	0.4014***	0.3993***	0.397***	0.297***	0.2389***	0.2398***	0.2449***	0.1502***	0.0444**	0.0437**	0.0434**	0.0781***
Rental	0.1339***	0.1333***	0.1328***	0.1316***	0.0545**	0.0544**	0.0521**	0.0255	0.0307*	0.0304*	0.0304*	0.0299*
Residential	0.1152***	0.1142***	0.1131***	0.1115***	0.1091***	0.1087***	0.1115***	0.113***	0.035**	0.0165	0.0162	0.016
Retail	0.2473***	0.2458***	0.2447***	0.2428***	0.1641***	0.1638***	0.1664***	0.1673***	0.0357**	0.0352**	0.035**	0.0349**
Self-Storage	0.1663***	0.1433***	0.1415***	0.1407***	0.1474***	0.1054***	0.1077***	0.1088***	0.0502**	0.0874***	0.0875***	0.0868***
Specialty	1.1947***	1.1993***	1.1741***	1.1228***	0.6226***	0.6115***	0.5962***	0.5634***	0.374***	0.367***	0.244**	0.2257**
Pre-GFC												
Diversified	0.157	0.1374	0.2471	−0.1745	0.2125**	0.1964*	0.2755	−0.276	0.2816***	0.2648**	0.5942**	0.4854
Healthcare	0.1951**	0.1921**	0.2306	−0.2533	0.1153*	0.1027	0.0929	−0.1093	0.169**	0.1656**	0.1678	−0.1854
Inds/Off	0.1702*	0.1649*	0.1026	−0.4307	0.1622**	0.1502**	0.1682	−0.3337	0.1954**	0.2065**	0.1628	−0.0869
Industrial	0.1806	0.1308	0.1541	−0.5098	0.1395	0.0976	0.1334	−0.6485	0.1982*	0.1577	0.0757	−0.4524
LDG/Resorts	0.2195**	0.182	0.2658	−0.0741	0.212**	0.1706	0.1507	−0.4746	0.2968***	0.276**	0.3531	0.1102
Office	0.0835*	0.0755	0.1009	−0.1188	0.0917	0.0836	0.0329	−0.2737	0.2574**	0.2532**	0.2656	−0.0397
Rental	0.1001*	0.1103*	0.1327	−0.3107	0.262***	0.2677***	0.3514*	−0.1697	0.1373**	0.1402*	0.2334	−0.0107
Residential	0.1524*	0.1138	0.1509	−0.3319	0.148**	0.1525*	0.224	−0.2447	0.1984**	0.2189**	0.2024	0.4514
Retail	0.1399*	0.1429*	0.1449	−0.2672	0.1276	0.1052	0.1528	−0.1175	0.1556**	0.1538**	0.1946	0.2006
Self-Storage	0.1524	0.1051	0.1829	−0.1548	0.1231	0.1044	0.2004	−0.2452	0.1816**	0.175**	0.0687	−0.156
Specialty	0.0452	0.0388	0.0555	0.1434	0.0325	0.0291	0.0061	−0.2017	0.0899*	0.0951*	0.1671*	−0.0018
Post-GFC – Pre-COVID												
Diversified	0.2289***	0.2273***	0.2225***	0.2386***	0.1103***	0.1093***	0.1081***	0.104***	0.026*	0.026*	0.0256*	0.0205
Healthcare	0.1008***	0.0997***	0.0965***	0.0965***	0.072***	0.0716***	0.0707***	0.0707***	0.0249**	0.0249**	0.025**	0.0191
Inds/Off	0.2408***	0.2395***	0.2348***	0.2546***	0.1531***	0.1519***	0.15***	0.1441***	0.0811***	0.0803***	0.0232	0.0223
Industrial	0.3444***	0.3422***	0.3348***	0.3573***	0.1435***	0.1426***	0.1411***	0.1343***	0.0256	0.0254	0.0254	0.0226
LDG/Resorts	0.6544***	0.6511***	0.6435***	0.6949***	0.3006***	0.2982***	0.2947***	0.2858***	0.0725**	0.0721**	0.07**	0.0717**
Office	0.2453***	0.2438***	0.239***	0.2555***	0.1384***	0.1372***	0.1355***	0.1316***	0.0261**	0.0259**	0.0258**	0.0243**
Rental	0.0895***	0.0888***	0.0867***	0.099***	0.0326	0.0326	0.0323	0.0068	0.0262*	0.026*	0.0256*	0.0182
Residential	0.11***	0.1091***	0.1061***	0.1134***	0.0788***	0.0783***	0.0775***	0.0763***	0.015	0.014	0.014	0.014
Retail	0.1854***	0.1838***	0.1806***	0.1954***	0.1154***	0.1143***	0.1133***	0.1099***	0.0313**	0.031**	0.0306**	0.0236
Self-Storage	0.1099***	0.1088***	0.1065***	0.1082***	0.0842***	0.0839***	0.0829***	0.0798***	0.0271*	0.0269*	0.0267*	0.0254

(*continued on next page*)

Table A2 (*continued*)

Sectors	Model A				Model B				Model C			
	In-Sample	Out-of-Sample			In-Sample	Out-of-Sample			In-Sample	Out-of-Sample		
		$h = 22$	$h = 66$	$h = 132$		$h = 22$	$h = 66$	$h = 132$		$h = 22$	$h = 66$	$h = 132$
Specialty	–	–	–	–	–	–	–	–	–	–	–	–
COVID												
Diversified	0.3204***	0.3076***	0.3012***	0.2879***	0.5508***	0.5321***	0.5524***	0.5526***	0.0937	0.0829	0.0593	0.0685
Healthcare	0.9436***	0.9176***	0.8525***	0.5114***	0.5025***	0.4883***	0.5033***	0.5568***	0.2771*	0.263*	0.2233	0.2196*
Inds/Off	0.8431***	0.8183***	0.7873***	0.7224***	0.5261***	0.5134***	0.5689***	0.547***	0.2458	0.2202	0.1846	0.1974
Industrial	0.0976	0.0925	0.0882	0.0816	0.2012**	0.1965**	0.2376***	0.2572***	0.057	0.0458	−0.0025	0.0417
LDG/Resorts	1.9767***	1.9179***	1.837***	1.7135***	1.6781***	1.644***	1.6816***	1.6608***	0.8137**	0.7355**	0.6923**	0.6276**
Office	0.552***	0.5332***	0.5063***	0.4851***	0.5471***	0.5425***	0.5895***	0.6072***	0.2282**	0.2208**	0.1954**	0.1974**
Rental	0.2923**	0.2825**	0.2705**	0.1947***	0.0792	0.0761	0.074	0.0856	0.1003**	0.0888*	0.0517	0.0441
Residential	0.1445	0.1356	0.12	0.1101	0.3547***	0.3479***	0.3761***	0.3799***	0.0864	0.0826	0.0444	0.0654
Retail	1.2913***	1.2486***	1.1844***	1.0966***	0.8305***	0.8124***	0.8373***	0.8254***	0.3108*	0.2937*	0.261*	0.2672*
Self-Storage	0.1194**	0.1159**	0.1024**	0.0935**	0.3737***	0.3629***	0.3969***	0.4017***	0.1935**	0.1895**	0.1244	0.1118
S pecialty	–	–	–	–	–	–	–	–	–	–	–	–

Note: The figures in each cell are the CW statistics that compare our predictive model with a benchmark AR(1) model. Positive and statistically significant CW statistics indicate a preference for our predictive model over the benchmark model. The ***, ** and * denote 1%, 5% and 10% significance levels, respectively.

Data availability

The authors do not have permission to share data.

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